Welding Engineer

PRICE 50 CENTS

NOVEMBER, 1959

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Capacity: 600 Amps, 100% Duty Cycle Length: 11" Weight: 28 oz.

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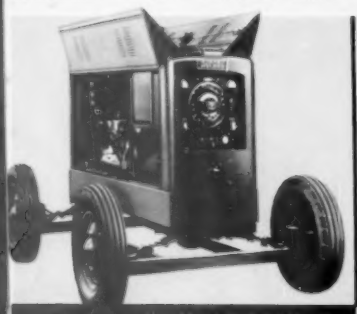

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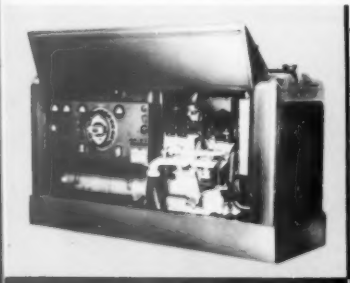

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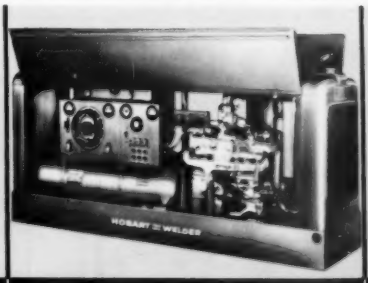

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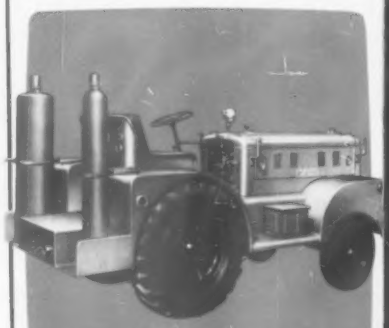

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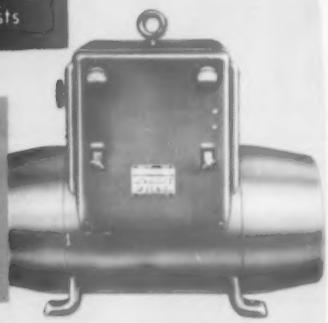
speeds production without adding manpower



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AUTOMATIC WELDING HEADS

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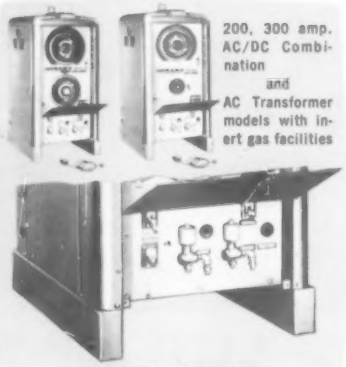

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Hobart Autoflux H-100 is also a new development answering todays demands for lower production cost. An excellent Flux for single pass butt and lap weld.

VOL. 44—No. 11

The magazine of joining and severing of materials

Welding Engineer

This is Welding: November, 1959

Specifications for welding thoriated magnesium 29

Mg

Research has indicated the new magnesium alloys have good weldability; however, which production welding processes to use and what the service requirements would be, still had to be answered. To serve as a guide, techniques designed for production processing of these thoriated-magnesium alloys are reported by author **Harlan Meredith.**

★ (For a reprint of this article, circle number 248.)

Another view of stress relieving 32

Correct judgment or mere habit—which is the measuring stick you use when considering stress relief of a weldment? Author **Louis J. Larson** gives his views on the application of this operation, which can be either an important manufacturing procedure or a needless expense burden.

★ (For a reprint of this article, circle number 249.)

Spot welding procedures and design 35

In his second and concluding article in a series on this resistance welding method, metallurgical engineer **Lester F. Spencer** discusses quality considerations as well as cracked welds, porosity, electrode pick-up, sheet separation and expulsion.

Procedures for welding 17-4 stainless steel 38

Strength, toughness and corrosion resistance retained over a wide temperature range places stainless steel in a wonder-metal category. Welding metallurgist **G. E. Linnert** describes the properties and welding procedures for one such stainless which has demonstrated good weldability under production conditions.

★ (For a reprint of this article, circle number 250.)

New aluminum alloy not prone to brittle fracture 42

Al

Fear of brittle fracture at low temperatures has impeded use of one of the newest and strongest aluminum-magnesium-manganese alloys. **R. D. Olleman** and **G. C. Wolfer** report on the extensive tensile and impact tests conducted on the alloy to prove this fear false.

Plastic welding fixtures add light-weight preciseness 66

Stable, high-temperature epoxy laminating resins combined with glass cloth provide the welding industry with a new, economical method of producing light-weight, precise welding fixtures. Author **John Delmonte** details the properties and production methods involved.

Also in this issue:

Hardfacing alloys increase manganese-steel life 41
Tube manufacturer prompted to make spot welders 46
Missile age rockets ahead as army enlists welding 52
Aluminum boom used for construction in Canada 69
Aluminum has bright future in piping industry 72
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Published monthly, with an additional directory number in June, by Welding Engineer Publications, Inc. Entered as second class matter Aug. 23, 1948, at the Post Office at Chicago, Ill., under Act of March 3, 1879. Printed in U.S.A. Tear sheets of many Welding Engineer articles available free of charge up to 3 months following date of publication.

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Ranite Hardsurfacing Rods are *So economical*

they're preferred by the men who pay the bills!

MEN RESPONSIBLE FOR COSTS—men who must hold expenses in line and show a profit—have seven important reasons for preferring Ranite metallic-coated hardsurfacing rods:

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Western District Manager
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Telephones:
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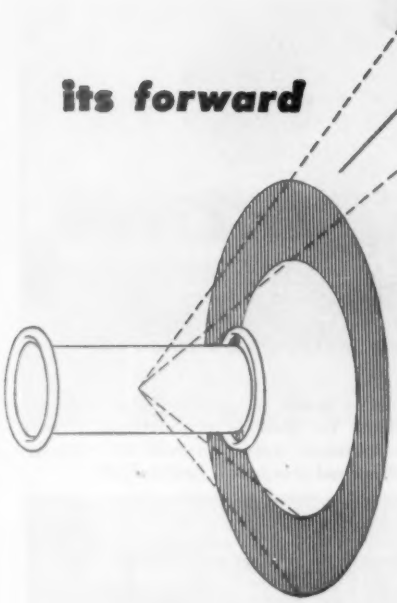
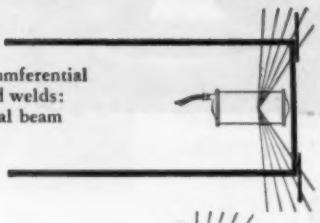
WELDING ENGINEER is indexed regularly by Engineering Index, Inc.

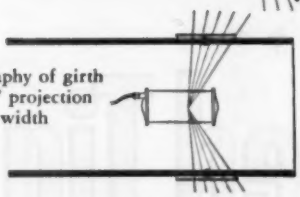
its *forward throw* 360° radial x-ray beam makes light work of tough radiographic jobs like these



Inside-out one shot circumferential radiography of tank-head welds: the forward-thrown radial beam gets the whole corner.



Circumferential radiography of girth welds: the wide-band 30° projection x-rays the full seam with width to spare on either side.



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Despite the power it packs, the tubehead is light enough for one man to handle.

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one man can easily carry its 72 lb. tubehead

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an investment that will pay manifold dividends for years for a modest outlay of **$5400**

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portable x-ray units—130 KV, 160 KV, 200 KV, 260 KV

x-ray units—5 to 50 KV, 150 KV (stationary and mobile), 270 KV portable, 260 KV heavy-duty

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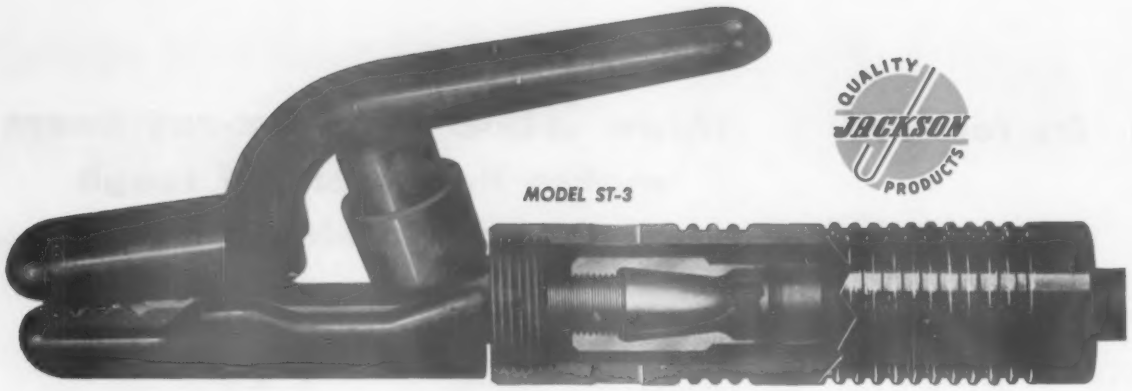
. . . films, tanks, darkroom sundries, illuminators, *everything*



QUALITY JACKSON PRODUCTS

new . . .
Sealed Tight

JACKSON SERIES ST electrode holders offer a *Sealed Tight* mechanical cable connection that gives you practically one-piece conductivity between cable and holder. Tongs are of heat-treated 98% copper alloy.

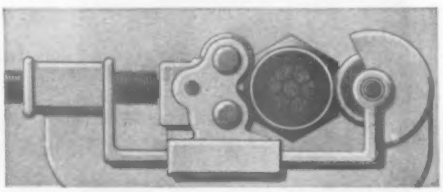
The stripped cable strands are completely *Sealed Tight* within a *connection nut*, making all-around *tight* metal-to-metal contact with the holder tong, *sealed* against moisture and dirt. The cable jacket is also *Sealed Tight*. The connection nut, by providing an all-around *tight* support of the cable jacket, allows no strain on the cable strands which usually occurs through flexure and tension.

This cable connection is quick and lasting, requiring no maintenance during the normal life of copper or aluminum cable.

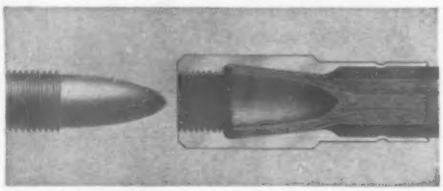
Large, ventilated handle threads onto a non-conductive asbestos bushing, has no direct metal contact with tong or cable connection, resulting in an extremely cool working holder. Should the "stinger end" of the holder require service of any kind, it may be quickly replaced without disturbing the actual cable connection. This important feature greatly reduces holder down-time and effects savings in cable cost.

Copper alloy lower jaw terminates in a point, silver-plated for greatest conductivity. When nut is tightened, cable strands are equally disposed around this point, *Sealed Tight*.

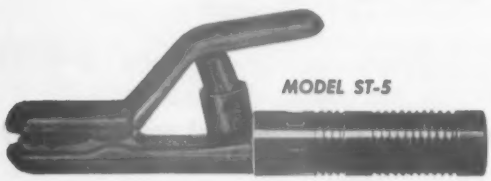
The nut extends backward, forming a ferrule around the cable jacket. This *Sealed Tight Connection Nut* is made in sizes to fit cables No. 1, 1/0, 2/0, and 3/0.



For a *truly permanent nut-to-cable connection*, the ferrule of the nut is crimped around the cable jacket, using Jackson's inexpensive, fast-acting crimping tool.



Detachable Stinger feature enables the operator to detach the "stinger end" by unscrewing it from the connection nut. The cable strands stay in place inside the nut.



Sold Everywhere by Better Welding Supply Dealers

MADE IN TWO SIZES . . .

Model ST-3, "Sealed Tight" Insulated Copper Alloy Holder Electrodes through ¼" • 300 Amps • 10" long

Model ST-5, "Sealed Tight" Insulated Copper Alloy Holder Electrodes through ⅜" • 500 Amps • 11½" long

Jackson Products

AIR REDUCTION SALES CO., A DIVISION OF AIR REDUCTION CO., INC.

WARREN • MICHIGAN

WILL Scott, product planning manager, Ford Div., Ford Motor Co., gave the opening address at AWS Fall Meeting in Detroit. He spoke on economy cars and predicted more than 1,000,000 sales of these units in 1960. Seated, from left: J. E. Dato, President C. I. MacGuffie and Secretary Fred Plummer.

AWS fall meet discusses new processes, techniques

New processes and techniques were discussed before a disappointing audience of about 500 men in Detroit for the first American Welding Society Fall Meeting to be held since 1956. Some 900 persons were expected to attend the meeting held in the Sheraton-Cadillac Hotel.

One new open-arc process was described in a paper prepared by R. A. Wilson of Lincoln Electric Co., Cleveland. The new entirely self-contained open-arc method welds at 200 ipm. All materials for welding are contained in the electrode, and no protecting gas is needed for the weld area since electrode coating ingredients vaporize and prevent harmful elements from combining with the molten metal.

The opening talk was given by Will Scott of Ford Motor Co. He discussed the future sales promise of the unitized-body compact cars being produced by American manufacturers.

Next month . . .

Safety

The December issue will be devoted to safe practices when welding and cutting and will also include a report on the National Safety Congress recently completed in Chicago.

NEWS

Square D construction moves on in Chicago

Construction is almost complete at one Chicago site and the ground has been broken for another area project of the Square D Co.

Finishing touches are being put on the firm's 56,000-sq-ft building in Schiller Park, a western Chicago suburb. This structure will house an assembling plant and sales offices for the west central and midwestern regions.

Ground has been broken in Park Ridge, another Chicago suburb, for a 43,000-sq-ft building to house Square D's corporate executive offices. The firm has been located in Detroit since it was founded in 1903, but hopes to complete the move to its new Chicago area headquarters by next summer (see *WeldWorld*, October, p. 14).

Midwest welding conference set for Chicago, Feb. 3, 4

Welding and brazing applications in the missile and aircraft industries will be among the major topics discussed at the sixth annual Midwest welding conference to be held in Chicago Feb. 3 and 4, 1960.

The conference is co-sponsored by Armour Research Foundation of Illinois Institute of Technology and the Chicago section of the American Welding Society.

Welding of ultra strength steels and refractory metals and welding and brazing on the B-70 bomber will be covered in three papers at the opening session of the meet.

Other sessions will be devoted to discussions of welding in the nuclear reactor industry, automotive industry and on pipe lines. Advances in welding stainless steel and the latest in nondestructive testing techniques will also be covered.

National safety council offers safety-talks book

Another in its series of five-minute safety talks for foremen is now available from the National Safety Council, 425 N. Michigan Ave., Chicago 11, Ill.

Book 9 contains 52 talks—one for each week of the year—written by a foreman. Subjects range from "Mind Your Own Business" to the "Wild Machine."

Chemetron Corp. building CO_2 recovery facility

Gibbstown, N. J., 15 miles southwest of Philadelphia, is the construction site of what Chemetron Corp.'s Cardox Div. says will be the largest facility in the northeast for the recovery of carbon dioxide from ammonia.

Daily production capacity of the new plant will be 155 tons of liquid and solid carbon dioxide. Raw materials will be obtained from an E. I. duPont de Nemours & Co. ammonia plant, and finished products will de distributed from Maine to Virginia in liquid and dry ice forms.

Douglas Clipp, manager of a Cardox division in Monee, Ill., will manage the new plant.

Plastic design theory lecture series in Chicago

A lecture series on the practical application of the new theory of plastic design for steel structures is in progress for Chicago area architects and structural engineers in Chicago's Engineering Building.

The American Institute of Steel Construction, Inc., New York City, is sponsoring the lectures, which take place each Tuesday from 7:30 to 9:30 p.m. until Nov. 10.

Similar six-part lecture series will also be given in other cities across the country. Lecturer for the Chicago sessions is Prof. E. H. Gaylord, Jr., of the Civil Engineering Dept. of the University of Illinois.

Fleet's in

FIRST of six new liquid oxygen and nitrogen trucks to be delivered to Pittsburgh, Calif., plant of Linde Co. Plant superintendent I. E. Barber (left) accepts delivery from Robert Hampton (center), president of LOX Equipment Co., builder of trailers, and Glenn Stevenson, of Peterbilt Motors Co., manufacturer of trucks. Liquid capacity is equivalent to 475,000 cu ft of gaseous oxygen or 385,000 cu ft of gaseous nitrogen.

Stamford facilities expanded by Branson

Branson Ultrasonic Corp., Stamford, Conn., has completed a 12,000-sq-ft addition to its existing building at 40 Brown House Road. The firm manufactures ultrasonic cleaning and gaging equipment.

Welding of aluminum studied at home

The Canadian Welding Bureau in conjunction with the Aluminium Laboratories, Kingston Ontario, is offering a home study course consisting of 22 lessons on the welding of aluminum.

Aluminium Laboratories has been offering a lecture series on the subject since 1946, but because of lack of time or the great distance involved, many people have been unable to attend the sessions. The welding bureau has revised the lectures into lessons which are mailed to participants at two or three week intervals.

CB&I to build Hortonclad vessels on commercial basis

The successful testing of a titanium-clad pressure vessel of commercial size has led Chicago Bridge & Iron Co. to set up facilities at its Birmingham, Ala., plant for the commercial production of such units.

Hortonclad vessels provide titanium's corrosion resistance at less cost than that of solid titanium structures.

The vessel tested in California was designed for a working pressure of 150 psi at 500 F. It is 4 ft in diameter by 12 ft high and was fabricated from ½-in. mild steel plates clad with 5/64-in. and 7/64-in. grade A-40 titanium. Hemispherical heads, top and bottom, each were welded from pressed segments. Fittings and flanges were titanium-lined.

COMING EVENTS

NOV. 2-6: 41st National Metal Exposition and Congress, International Amphitheatre, Chicago.

NOV. 19-20: University of Wisconsin Annual Welding Institute, "Stainless Steel Welding," Wisconsin Alumni Center, Madison.

NOV. 30-DEC. 1: NWSA Southeastern Zone Meeting, Atlanta Biltmore Hotel, Atlanta.

DEC. 3-4: NWSA Southwestern Zone Meeting, Hotel Texas, Fort Worth.

JAN. 20, 1960: Metallurgical Society of AIME, Flat Rolled Products Conference, Del Prado Hotel, Chicago.

JAN. 25-28, 1960: Plant Maintenance and Engineering Show, Convention Hall, Philadelphia.

FEB 3-4, 1960: Midwest Welding Conference, Illinois Tech Chemistry Building, Chicago.

APRIL 25-29, 1960: 41st Annual Convention, AWS, The Biltmore Hotel, Los Angeles.

Distributor appointments

Ampco Metal Inc., Milwaukee: Acme Welding Supply Co., Kansas City, Mo.; Aviation Service Supply Co., Denver, Colo.; Essex Welding Equipment Co., Newark, N. J.; Welders Supply Inc., Dallas, Tex.; Johnston Engineering Sales Co., Wayland, Mass. (centrifugal pumps).

Rivett Inc., Boston: Kerns-Morrell Co., Detroit.

A. O. Smith Corp., Milwaukee: Northern Gases & Supply Inc., Milwaukee.

Tube Turns, Louisville: Star Corp., Freeport, Tex.; Longhorn Supply Co., Inc., Houston.

(Additional news on page 78)

Special training sessions held for industry

STUDENTS in nondestructive testing training course conducted regularly by Magnaflux Corp. at its Chicago plant. This year, 13 such five-day (40 hour) sessions have covered the basics, theory and practice of testing. Under direction of H. E. Van Campen, each student receives individual attention and is able to process some of 800 pieces with known defects. Each of eight students in class learns theory of magnetic particle and fluorescent penetrant inspection, etc.

PROPER service and maintenance procedures for A. O. Smith Corp.'s multi-operator welding power source system were detailed to over 60 users during a recent training session at Union, N. J. Full-day meeting was conducted by A. E. Johnson and Dennis Pierce (right), engineers from firm's welding products division. Representatives of J. B. Nottingham Co., suppliers of grids and junction boxes, described operation of their products. Typical 1,500-amp unit shown was used to illustrate procedures.

here is an outfit which will make you proud to own it . . .

With a most acceptable price tag goes the very highest quality and safety your money can buy . . .

only $89.50

By all means — look at other "package" outfits first to make you the more certain that this one is the best for you.

• • •

here's why this combination welding and flame cutting outfit is actually the very finest your money can buy...

This new outfit, the Five Star Pak, was designed particularly for the smaller shop, for farm use, garages, the hobbyist, or any one whose welding and cutting operations are diversified and more limited in scope and metal thicknesses . . .

An economy outfit can be economical only if it will perform well and for many satisfying years to come. If it fails to meet highest standards, it ceases to merit all consideration . . .

Extendable? By all means. This Five Star Pak is amazingly versatile. It may be extended as the needs expand. Larger or smaller nozzles or tips fit the torches as do multiple flame nozzles so convenient for many brazing operations. The cutting attachment, for instance, may cut easily up to four inches of steel thickness.

You can buy with confidence from a company which has been in the business of making fine equipment for nearly fifty years.

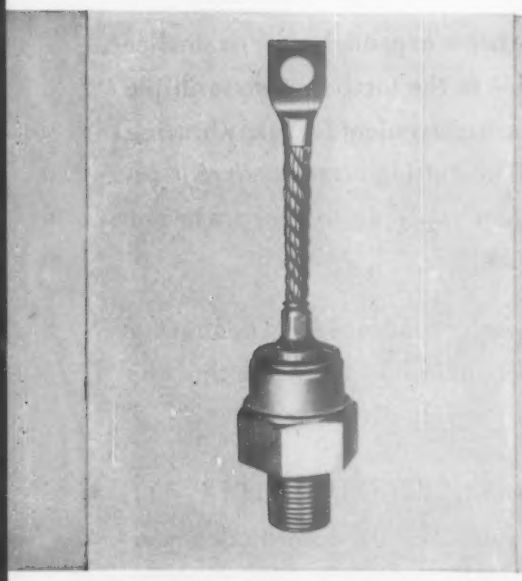
WRITE FOR THE ILLUSTRATED FOLDER #17 which gives you all of the information you ought to consider . . .

552 DEPT.

NATIONAL welding equipment company... 218 fremont street san francisco 5 california

new . . . Silicon Type WS

200, 300, 400 and 500 Amperes
230/460 Volts
60% Duty Cycle



Silicon diodes in the three-phase, full-wave rectifier are the heart of the WS welder. These diodes have a capacity far in excess of the rating for the welder and are hermetically sealed against dust, oil, water and acid fumes by a new bonding process. Each diode is thoroughly tested before and after insertion in the bridge.

Watch Westinghouse for New Developments in Welding

Rectifier Welder

- *Maximum Performance at Minimum Cost*
- *Highest Degree of Electrical Efficiency*
- *Most Compact Welder in the Industry*
- *Extremely Low Maintenance*

The Type *WS* silicon rectifier welder reflects engineering skill of the highest order. This welder is designed for maximum performance and reliability. It is a product of experience—developed in the Westinghouse laboratories and tested in the field under a variety of conditions. The welder you purchase will be checked out in every detail before it leaves our factory. Every conceivable precaution has been taken to assure you of a faultless piece of equipment.

Westinghouse pioneered this completely new concept in industrial welding machines over 10 years ago. Since that time another refinement of the rectifier-type welder was achieved by Westinghouse through the use of silicon diodes. The ultimate in silicon rectifier machines is the Westinghouse Type *WS*.

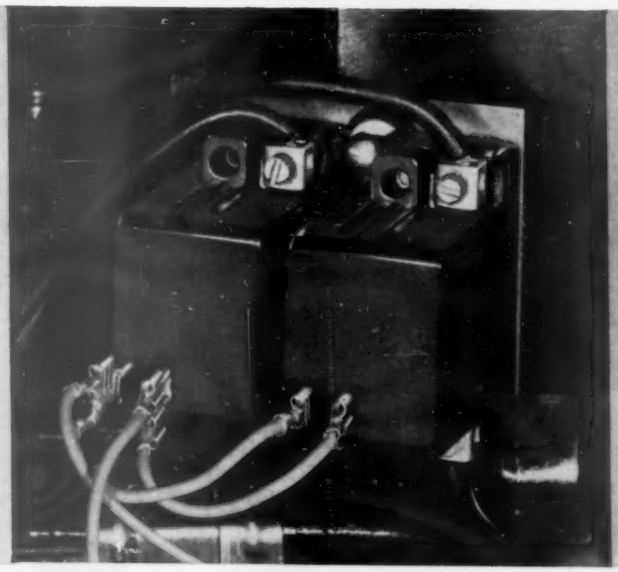
No other welder on the market has the electrical circuitry to produce sound quality welds as consistently as the *WS*. It provides easier starting, arc stability and maximum drive. Silicon rectification means top welding performance.

The *WS* is the lightest, smallest machine on the market. It is easy to handle and is a space saver. Its bonderized steel casing, protected by baked-on enamel, gives it a weatherproof construction. The high-quality materials in this welder will render long life and trouble-free service.

Learn more about this reliable source of power for welding!

Contact your nearest franchised Westinghouse welding distributor—or write: Welding Division, Westinghouse Electric Corporation, 4454 Genesee Street, Buffalo 5, New York.

J-22150



The inverse time relay shown here allows adequate time delay for arc starting at high current setting and freedom from nuisance power interruptions—yet it protects against serious short circuit faults. Capacitors divert and store peak, high-value, short-time voltage spikes that occur when electrical current is broken.

The Type WS has virtually no moving parts to wear out; thus, replacement is at a minimum. The easy access panel shown here makes routine maintenance and air cleaning of the rectifier bridge a fast, simple operation. Be cost-wise, avail yourself of this extremely low maintenance!

YOU CAN BE **SURE**... IF IT'S **Westinghouse**

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

NOW They are ALL Trade Marked

CURV-O-MARK

The Most Advanced Line of Welding Aids Ever Produced for

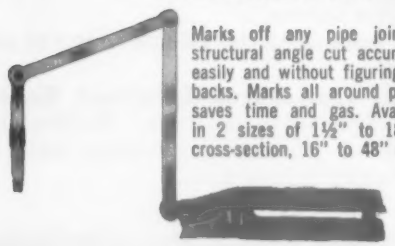
PIPE-LAYOUTS

of ANY Type or Location

Since 1946 we have manufactured four patented welding aids, which are today recognized by Welders and Pipeline Construction Workers as the most reliable and accurate tools ever devised for marking pipes and structural angle cuts of any type, or at any location. Now, after nearly 14 years, we have adopted a Trade Mark for quick identification of each Marking Device — and here they are —

CURV-O-MARK

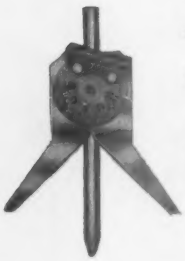
CONTOUR MARKERS



Marks off any pipe joint or structural angle cut accurately, easily and without figuring cut-backs. Marks all around pipe—saves time and gas. Available in 2 sizes of 1½" to 18" in cross-section, 16" to 48" diam.

CURV-O-MARK

CENTERING HEADS



Really, 5 tools in one — it replaces Protractor, Centering Head, Center Punch, Level and Scale. Eliminates difficult measuring, checking and marking Pocket size—weight only 9 ozs.

CURV-O-MARK

PIPE FLANGE ALIGNERS

For Aligning Slip-on, Top Joint, Stub End and Welding Neck Flanges. This self-centering Tool is quickly adjustable for all types of Flanges or Pipe sizes from 3" to 12" in diameter.

CURV-O-MARK

RADIUS MARKERS

Has marking span of 24" and swings to 48" circle or arc. Pencil holder accommodates round or flat pencils, soapstone and steel points. Unequaled for accurate layout work. Wt. 8 oz., pocket size.

Your Welding Supply Dealer Recommends all CURV-O-MARK Products

CONTOUR SALES CORPORATION

1843 E. COMPTON BOULEVARD • COMPTON, CALIFORNIA

Pipeline News

Equitable Gas Co., Pittsburgh, has received authorization to construct natural gas facilities in West Virginia and Pennsylvania at a cost of $1,250,000, says the Federal Power Commission.

Michigan Wisconsin Pipe Line Co., Detroit, has received FPC approval for construction to cost $31,157,000. This will include 352.9 miles of 24-in. pipeline and 16,560 hp in added compressor capacity. Major construction is located in Kansas, Missouri, Iowa, Illinois and Michigan. Also granted to Michigan Wisconsin was authority to build 20.9-miles of 16-in. loop pipeline to relieve pressures on Green Bay and Two Rivers lines.

The Manufacturers Light & Heat Co., Pittsburgh, has FPC authorization to construct 60 miles of 20-in. line, and 700-hp compressor at a cost of $5,380,000. These facilities are all in Pennsylvania.

El Paso Natural Gas Co., El Paso, has FPC authorization to construct facilities for a total cost of $5,000,000, with no single project to exceed $500,000. Included in El Paso's single projects are: field lateral lines, dehydration facilities, and gasoline compressor facilities, purification and plant facilities.

FPC authorization for a $49,088,000 project has been given to Texas Eastern Transmission Corp., Shreveport, La., to expand its system, in order to transport an additional 101,660,000 cu ft of natural gas daily. These new facilities include: 100 miles of pipeline loops, 22 miles of 14-in. supply line, and 185,070 hp to be added to compressors on Texas Eastern's system in Kentucky, Louisiana, Mississippi, New Jersey, Ohio, Pennsylvania, and Tennessee.

"Joe started out at the bottom with us, and he's been losing ground ever since."

WELDING ENGINEER

Your November, 1959 Weld World

As WE went to press, these were the industry's latest developments:

. . Goldsmith Bros. Smelting & Refining Co., Chicago, is now a division of National Lead Co.

. . Linde Co. distributors will now handle Oxweld oxyacetylene welding and cutting apparatus, Sigma equipment for Mig welding, and Unionmelt equipment and supplies for submerged-arc welding. These lines previously were sold on a direct manufacturer-to-consumer basis.

. . General Ceramics Corp., Keasbey, N. J., which makes gas cups for Tig torches, has merged with Indiana Steel Products Co., Valparaiso, Ind., to form Indiana General Corp. Both firms will operate as divisions.

. . Wheelabrator Corp., Mishawaka, Ind., manufacturer of airless blast cleaning equipment, has acquired Lake Erie Machinery Corp., Buffalo, N. Y. The latter firm makes hydraulic and extrusion presses for metal-working industries. It will operate as a subsidiary.

. . Most forecasts for 1960 agree that it should be a banner year. But steel strike continues to provide uncertainty. As this page went to press, President Eisenhower was contemplating use of Taft-Hartley injunction provision which would put strikers back to work for at least 80 days. Steelworkers' union says it will fight the move in the courts.

. . Resistance-welding equipment sales for 1959 are running about 40% ahead of last year.

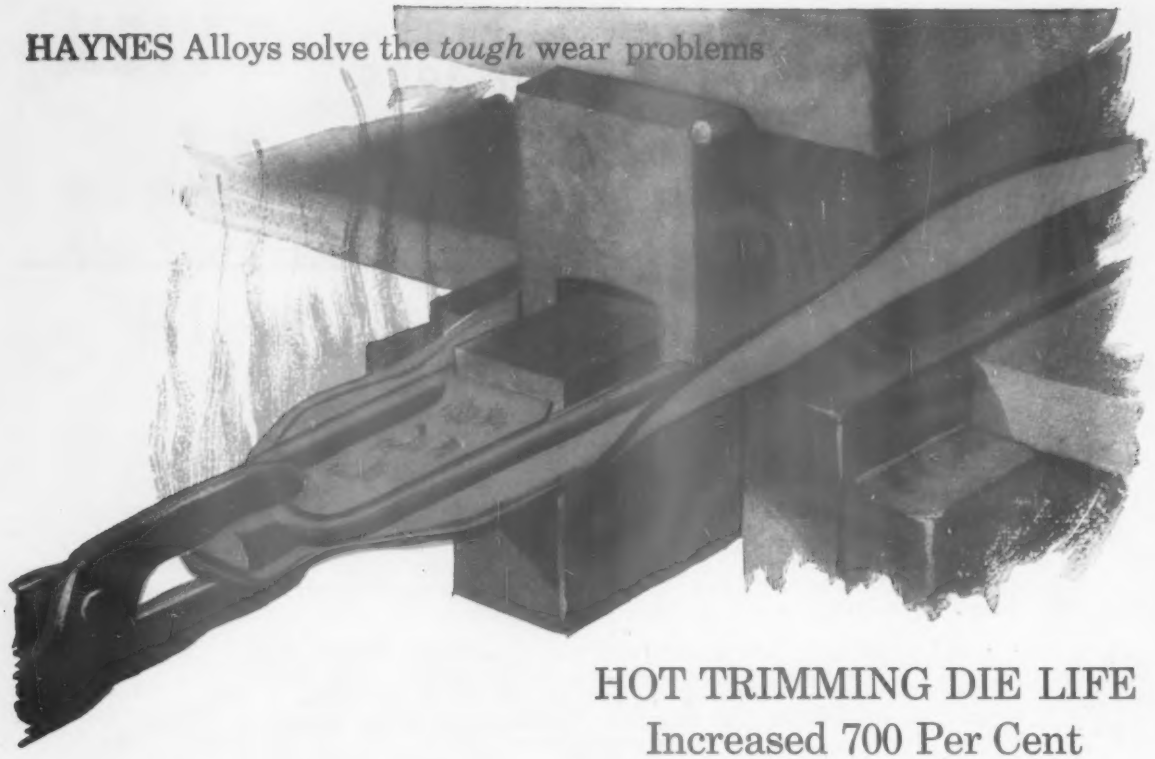
. . The Budd Co. has purchased Cleveland Welding Division of American Machine and Foundry Co. Budd also has acquired Lewyt Mfg. Corp., Long Island City, N. Y. The latter, manufacturer of electronic products, will operate as Budd Lewyt Electronics, Inc., a wholly owned subsidiary.

. . Bridgeport Brass Co.'s Bridgeport, Conn., plants, struck for four days, are back in operation after ratification of a two-year labor agreement with the Brass Workers Union.

. . As reported months ago by WELDING ENGINEER and THE WELDING DISTRIBUTOR, the Big Three's new "economy" cars are of unitized construction...body and frame are one weldment. Also, all Chrysler Corp. models, with exception of the Imperial, have adopted this method of fabrication. Rambler has been unitized for years, as was its forerunner, the Nash.

. . Air Products, Inc., Allentown, Pa., is building oxygen plants at four steel-producing sites. Owned and operated by Air Products, two will supply oxygen to Jones & Laughlin Steel Corp. plants at Cleveland and Pittsburgh; one at Granite City (Ill.) Steel Co.; the fourth at Weirton (W. Va.) Steel Co., division of National Steel Corp. Substantial percentages of the Cleveland and Granite City outputs will be available to other industrial gas users in each area.

HAYNES Alloys solve the *tough* wear problems



HOT TRIMMING DIE LIFE
Increased 700 Per Cent

HAYNES hard-facing alloys resist the sudden shock of impact and the softening effects of heat . . . two characteristics that make them unusually successful in extending the service life of hot-working equipment. In one plant, hot-trimming dies hard-faced with a HAYNES cobalt-base alloy removed the flash from 25,000 parts before they had to be reconditioned. This was a 700 per cent increase in service life over unprotected dies. In this instance the parts were heated to 2000 deg. F just prior to the trimming operation.

If you have a problem involving a combination of heat and impact, straight abrasion, or corrosion, you will find that there is a HAYNES hard-facing alloy that can solve it . . . economically. The hard-facing deposit will increase the service life of the part and, because of its superior wearing qualities, permit you to use a less expensive base material.

Write for literature or call one of our sales offices. HAYNES STELLITE COMPANY, Division of Union Carbide Corporation, Kokomo, Indiana. Sales offices in Chicago, Cleveland, Detroit, Houston, Los Angeles, New York, San Francisco.

This trimmer die, being touched up with a HAYNES nickel-base alloy, has trimmed over 20,000 parts. The hard-facing alloy is tough, machinable, and can be applied to all common die steels by the metallic-arc process.

HAYNES
ALLOYS
HAYNES STELLITE COMPANY
Division of Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

The terms "Haynes" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

32,000 VARIATIONS OF WELDER CONTROL AVAILABLE FROM STOCK!

Square D "Building-Block" Construction means fast delivery of the Control you need

• When you need welder control—for any welding function—Square D can give you what you want, when you want it. More than 32,000 combinations of enclosures and plug-in panels can be made up from off-the-shelf stock to meet your exact requirements. The result—your control is made to order, thoroughly checked and tested, and shipped without delay. Similar facilities exist in warehouses from coast to coast, and warehouse stocks of plug-in panels are also available to assist Square D field engineers in on-the-spot service. • Square D plug-in construction lets you add control functions as you need them. Panels perform all NEMA standard functions, with either tube or relay firing, including heat, slope, current regulator, dual functions, forge and anti-repeat initiation. All NEMA standard enclosures are available, with or without disconnect switch, as well as enclosures to meet JIC specifications or your own special requirements. You can get the welder control you need from Square D—quickly!

Write for details. *For the complete story on Square D welder control, write for Bulletin SM-277. Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin*

SQUARE D COMPANY

—wherever electricity is distributed and controlled

ATLAS | WIDE-BLADE TOMAHAWKS

WORLDS LEADING WELD CLEANING TOOLS

If Possible—They're Better than Ever!

Atlas "Dual Tools" are favorites with welders who like the idea of having the brush handy at all times. Now these tools are even more efficient than ever with our new wide blades—18% more chipping edge, more speed, fewer resharpenings, less worker fatigue. Choose your "Dual Tool" with the grip you prefer and the bit that best suits your likes. Ask your dealer for our FORM WCT-250 describing all our models.

Tough as they come!

33 MODELS

Each Atlas tool is made as well as we know how. Ask your welding supply dealer to show you the complete line.

ATLAS WELDING ACCESSORIES INCORPORATED
707 E. LEWISTON
FERNDALE 20, MICH.

Letters . . .

Takes issue

Sir: *Sparrows Point, Md.*

The intent of Mr. W. L. Wilcox of the Arcos Corp. is commendable; *[How to get better stainless steel welds,* WE, *Sept., p. 32].* However, a closer adherence to the facts appears in order.

First: the sketch preceding the article makes reference to an AWS 309-LC electrode. The AWS specification and nomenclature does not include such an electrode.

Second: the weld metal from titania coated electrodes is not more crack sensitive than from lime coated electrodes. Rather, due to the better wetting action of the titania electrodes, the deposits are less convex than from lime electrodes. It is this reduced throat thickness rather than inferior weld metal that causes more frequent cracks in the titania deposits. When travel speed is reduced and deposits of comparable geometry are deposited, the titania electrode deposits are as crack resistant as lime electrode deposits.

It may be that with certain brands, the titania deposits are inferior to lime, but industry-wise this is not the case.

Third: there are a-c/d-c titania electrodes on the market that have arc stability and spatter of comparable levels whether using a-c or d-c.

E. B. Lutes
Arcrods Corp.

September editorial

Sir:

Your editorials are always very fine. In my opinion the one appearing in the September issue titled *Obsolete before he starts* is especially appropriate for individuals at a Midwestern university. If you would send 15 tear sheets of this particular editorial, I would place one in the mail boxes of each Civil and Design Engineer professor. I think it may be an eye-opener.

Name withheld on request

Sir: *San Luis Obispo, Calif.*

Your interesting editorial in the September issue has been brought to my attention, and I feel you might be interested in our philosophy of teaching engineering here at California State Polytechnic College.

Our school draws students from high school and junior college who are interested in a B. S. in engineering, but who are not going beyond for an advanced degree. Therefore, our approach

is one of strong vocational orientation. We have had much encouragement from industry in our program because of our graduates' ability to start right in on a job without further training.

We have maintained a Welding Dept. whose sole responsibility has been the teaching of the latest welding processes (by the "get in there and do it yourself" method). The Welding Dept. this year has branched out and has become the Welding and Metallurgical Engineering Dept.

L. F. Osteyee

Formal protest

Sir: *Memphis, Tenn.*

I received a letter today from the National Classification Board of the Motor Carrier Industry, the mouthpiece of the trucklines, advising that all ornamental castings would be shipped to the ornamental shops under Classification No. 16478. This classification under LTL carries 100%, or a first-class merchandise rate. In truckloads it is 70% of first class. In the past, the commodity has been rated in truckload quantities at 35% of first class and LTL as 50% of first class. In other words, up to today it has been rated as a fourth-class item.

We are making a formal protest and it would be helpful if you, too, would make a protest—directed to Mr. N. F. Behme, Jr., Chairman of the National Classification Board, 1424 Sixteenth St., N. W., Washington 6, D. C. In fact, if you are so inclined, a telegraphic message to Mr. Behme would be most helpful. I also suggest that you try to induce your customers to protest this action as it will double their present cost of freight on all castings, urns, knobs, shoes and many other items that they are buying made of cast iron or aluminum.

A telephone call is being placed to Mr. Behme in an effort to find out if there is not some technicality under which this docketing or classification can be changed. If anything further develops, you will be notified. From past correspondence and conversations it looks like a knock-down, drag-out battle between ornamental shops and trucklines, and for all economy's sake, we may have to resort to the railroad —especially on large shipments. Frankly, we can ship cheaper by air freight to most points.

If you would like to send a carbon copy of your letters, telegrams or other materials reflecting this protest, I shall be most happy to keep a file so that the necessary action in response to any of your letters can be handled by all of us. Your full cooperation is urged.

Abe Sauer
Tennessee Fabricating Co.

NEW NEW NEW NEW NEW NEW NEW NEW NEW

WHEN IT

MELTS

you know the *temperature!*

the easy modern way to determine exact working temperatures!

Just mark or stroke the surface with THERMOMELT . . . when it reaches the desired temperature, the mark liquefies. There's no guesswork, no wasted time or material . . . THERMOMELT is the quick, precise way to determine heating temperatures. Accurate to within ±1%.

A STIK FOR EVERY TEMPERATURE from 113°F. to 2000°F.

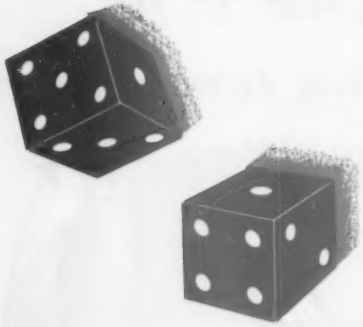
ALSO AVAILABLE IN LIQUIDS AND PELLETS for inaccessible or hard-to-measure applications. Wide range of temperatures.

Send today for free THERMOMELT literature and pellet sample (indicate temperature desired).

MADE BY THE MANUFACTURERS OF MARKAL PAINTSTIK MARKERS AND PROTECTIVE COATINGS

MARKAL COMPANY 3108 West Carroll Avenue, Chicago 12, Illinois

don't gamble



buy

HARRISBURG CYLINDERS

Why risk carrying high pressures in run-of-the-mill cylinders? For the same investment you can have the extra insurance of CYLINDER DESIGN proven by time and service. Harrisburg's design puts emphasis on both the cylinder's ability to contain high internal pressures, and to consistently withstand the shock and fatigue incurred during decades of rough handling.

Harrisburg's hot-drawing process permits the graduation of cylinder wall thickness to increase strength where it is needed most — at and around the cylinder base. And to insure positive gas-tight sealing, highly accurate ramp gauges are used to obtain precision neck threading on every cylinder.

Procedures such as these make Harrisburg cylinders the world's most dependable. Don't gamble. Buy quality. Buy Harrisburg.

More than a Century in Harrisburg 8, Pa.

H HARRISBURG STEEL CO.

Division of HARSCO CORPORATION

TUBES

TRANSPORTS

FLANGES

COUPLINGS

30 YEARS AGO

(Taken from the WELDING ENGINEER of November, 1929)

C. J. Haines, vice-president and general manager of the Keith Dunham Co., Chicago, visited London early this month. He is making an extensive trip through European industrial centers.

30 YEARS AGO

A. V. Fausek has been appointed district sales manager for the local St. Louis territory by Modern Engineering Co.

30 YEARS AGO

E. L. Mathy and W. S. Heasley of Victor Equipment Co., San Francisco, stopped in Chicago late last month following an extensive trip through the eastern states.

30 YEARS AGO

C. E. Philips formerly district manager of the Purox Co. at Detroit, has recently organized the firm of C. E. Philips & Co. with headquarters at 633 W. Larned St., Detroit.

30 YEARS AGO

A consolidation of the Thomson Electric Welding Co., Lynn, Mass., and the Gibb Welding Machines Co., Bay City, Mich., has been announced . . . the new company to be known as the Thomson-Gibb Electric Welding Co. Both plants will continue in operation.

30 YEARS AGO

Papers on electric arc welding were read before the Association of Iron and Steel Electrical Engineers in joint conference with Pennsylvania State College in Pittsburgh by K. L. Hansen, Northwestern Mfg. Co., Milwaukee, and J. F. Lincoln, Lincoln Electric Co., Cleveland.

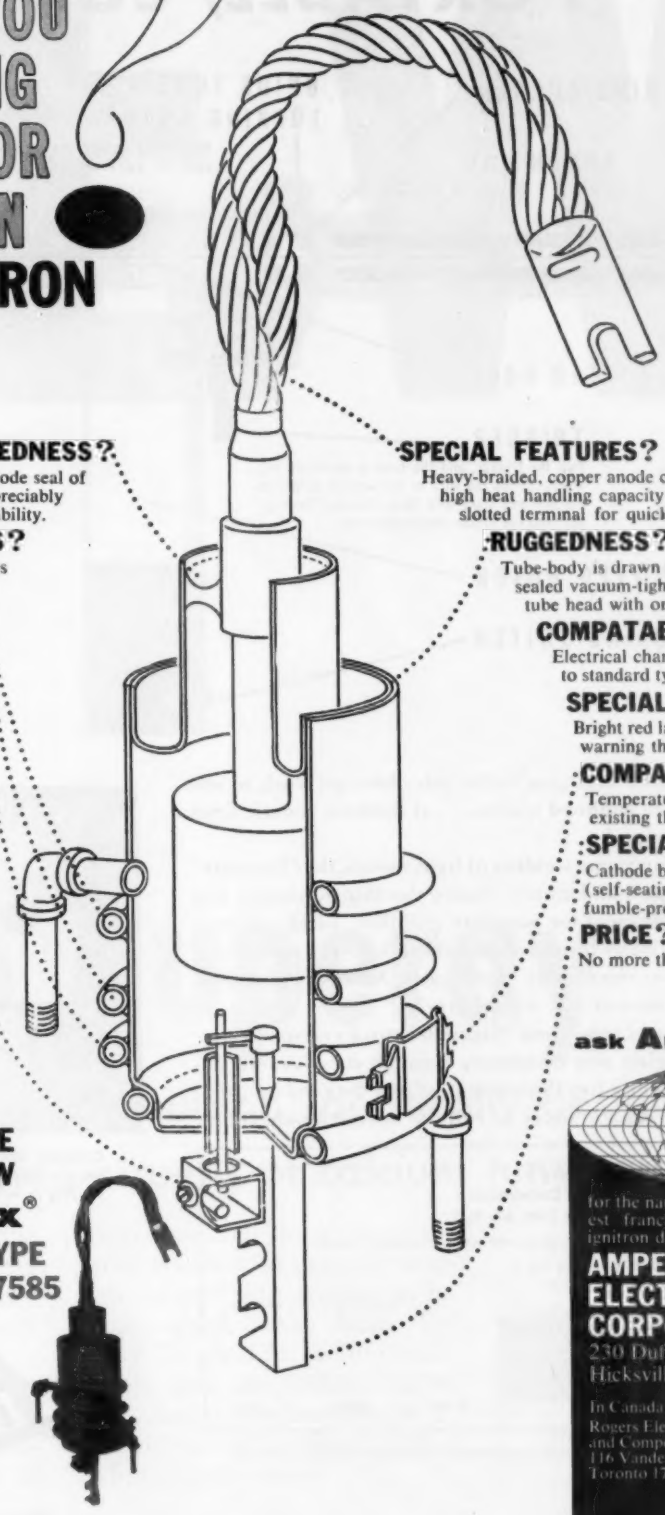
30 YEARS AGO

Miles C. Smith, former western manager of "The Welding Engineer," was recently appointed promotion manager for the Stoody Co., Whittier, Calif.

30 YEARS AGO

Fred Squire, formerly in charge of sales in the Chicago District for the Alexander Milburn Co., is now representing the Chicago Grinding & Machinery Co., distributors of K-G welding and cutting apparatus.

WHAT ARE YOU LOOKING FOR IN AN IGNITRON?



RUGGEDNESS?
A sunken compression-type anode seal of extremely rugged construction appreciably reduces tube's vulnerability.

COMPACTNESS?
Compact tube design saves precious space in contactor cabinet.

BETTER COOLING?
Scientifically distributed copper cooling coils ensure optimum temperature throughout tube. (Cooling is greatest around discharge chamber and cathode where most needed, proportionately less around anode to protect against arc-back.) Unique Amperex cooling system reduces sedimentation and minimizes water consumption.

SPECIAL FEATURES?
Easily accessible ignitor connection to fast firing ignitor provides convenience of either plate-cap or solid-screw connectors.

COMPATABILITY?
Completely interchangeable with all existing C-Type tubes.

PERFORMANCE?
... You cannot buy a better ignitron!

SPECIAL FEATURES?
Heavy-braided, copper anode cable with high heat handling capacity also features slotted terminal for quick change.

RUGGEDNESS?
Tube-body is drawn from one piece and sealed vacuum-tight to newly designed tube head with one single-seam weld.

COMPATABILITY?
Electrical characteristics identical to standard type 5552A.

SPECIAL FEATURES?
Bright red lacquer coating gives warning that tube is "alive."

COMPATABILITY?
Temperature sensing plate fits all existing thermostats.

SPECIAL FEATURES?
Cathode bar has angled slots (self-seating) for quick, fumble-proof installation.

PRICE?
No more than ordinary ignitrons.

THE NEW Amperex® TYPE 7585

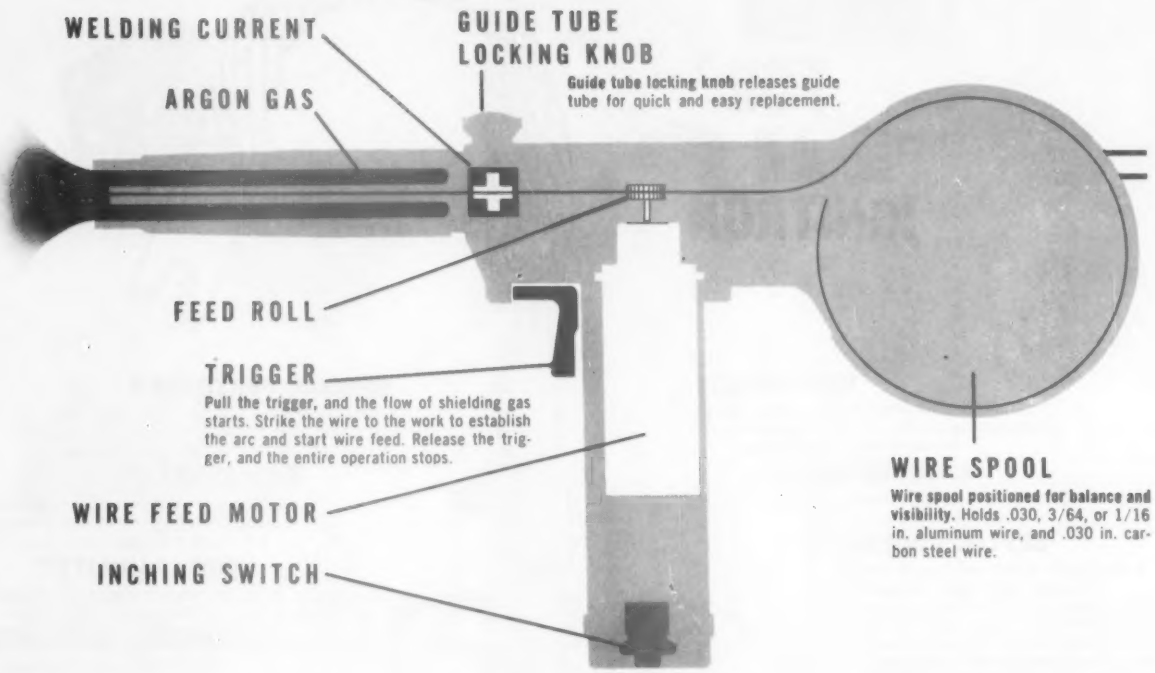
ask Amperex

for the name of your nearest franchised Amperex ignitron dealer.

AMPEREX ELECTRONIC CORPORATION
230 Duffy Avenue
Hicksville, L. I., N. Y.

In Canada:
Rogers Electronic Tubes and Components
116 Vanderhoof Avenue
Toronto 17, Ontario

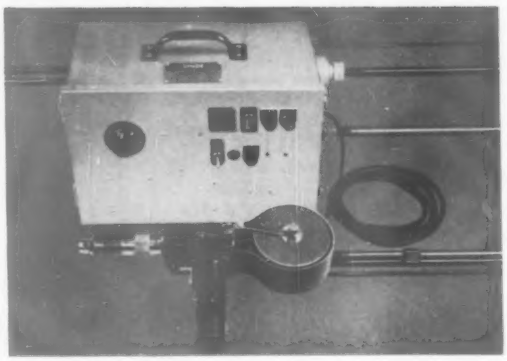
Try LINDE'S New "SIGMETTE" Torch!
—PORTABLE, COMPACT


WELDING CURRENT
ARGON GAS
GUIDE TUBE LOCKING KNOB
Guide tube locking knob releases guide tube for quick and easy replacement.
FEED ROLL
TRIGGER
Pull the trigger, and the flow of shielding gas starts. Strike the wire to the work to establish the arc and start wire feed. Release the trigger, and the entire operation stops.
WIRE FEED MOTOR
INCHING SWITCH
WIRE SPOOL
Wire spool positioned for balance and visibility. Holds .030, 3/64, or 1/16 in. aluminum wire, and .030 in. carbon steel wire.

Here's the torch that goes to the job—lets you work in any position . . . in confined spaces . . . at distance remote from the power source!

Designed for Sigma welding of light metals, the "Sigmette" torch is compact and sturdy. Notice the thin silhouette and position of the spool for complete visibility. Torch and control are completely insulated and grounded—the operator is protected from electrically "hot" parts. And the only maintenance tool needed is a screwdriver!

Find out how Linde's new "Sigmette" torch can speed your operations, bring new economies through its advanced design features. For a free demonstration and detailed information, mail the coupon today or call the nearest Linde Office.



Complete unit—torch weighs 3 pounds, 1 oz.; control weighs 19 pounds, 2 oz.; Current rating, 125 to 200 amp.; Welding power, direct current reverse polarity

Dept. WE-11, Linde Company
Division of Union Carbide Corporation
30 East 42nd Street, New York 17, N. Y.

☐ Please send complete facts on the new "Sigmette" torch.
☐ Please arrange to let me try it.

Name_____

Firm Name_____

Street_____

City_____ Zone_____ State_____

"Linde", "Sigmette" and "Union Carbide" are trademarks of Union Carbide Corporation.

Linde UNION CARBIDE

NEW

Ansco Superay 'D'

An ultra-speed x-ray emulsion specifically designed for use with intensifying screens of calcium tungstate types

Here at last is an all new fine grain film that has extremely wide latitude when exposed either by direct x-rays or with lead screens.

Try this superb new film and see the consistently superior results in flaw detection through specimens having a wide range of thicknesses. All this plus higher performance with calcium tungstate intensifying screens to increase speed, make Ansco Superay 'D' ideal for testing heavy metals with low voltage equipment. Ansco, Binghamton, N.Y., A Division of General Aniline & Film Corporation.

Ansco

Industrial X-ray

brazed successfully with

SILVALOY

LOW TEMPERATURE SILVER BRAZING ALLOY

Wherever trowels are used, the "Hahn" trademark is the recognized symbol for finest materials, highest standards of manufacture and balanced design. Trowels take rough, rugged usage and "Hahn" makes tools to deliver dependable, prolonged service.

The component parts of Hahn trowels are torch-brazed on a turn-table arrangement — using Silvaloy 45 and AP & S #1200 flux to be certain joints are as strong as the steels they join.

Silvaloy Brazing Alloys and APW Fluxes are helping to speed production, lower costs and improve brazing results in many fields. Call your nearest Silvaloy Distributor for information or technical assistance.

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BETWEEN PASSES

still more

Our two recent reports about the use of metered envelopes to promote welding have prompted Harry Shannon of Capital Welding Supply Co., Little Rock, to write us that he has been using the word "WELD" on his postage meter for about 10 years. As far as we can ascertain, that is the record. We would like to hear from more readers who promote the industry in this—or any similar—manner.

recognition

Speaking of promotion, we note more and more consumer advertisements are using welding equipment and accessories as part of their illustrations—and very often when welding itself has little or nothing to do with the product being advertised. A recent Coca-Cola ad shows a weldor taking a Coke break. He's handling a Tweco electrode holer.

Another ad in the New York *Times* (for that state's department of commerce) depicts a safety hard hat manufactured by Fibre-Metal Products.

Nice publicity for both firms.

missionary

A recent visitor to Chicago was the Rev. Vincent M. Cowan, a Maryknoll missioner stationed in Chile. Father Cowan is in hopes of establishing a welding school in his parish in Talcahuano, site of a large steel mill. A perfect spot for a welding school—something the South American country does not have. The town is about 350 miles south of Santiago, the capital. Fr. Cowan is trying to enlist the aid of equipment manufacturers in his task—hence his visit to this area. We wish him success.

good choice

We are happy to see that the new United Engineering Center now being erected at the United Nations Plaza in New York City is to have an all-welded steel frame. Former president Herbert Hoover, representing 300,000 members of 18 major engineering societies, broke ground on Oct. 1 for the 18-story structure. The American Welding Society is among the groups whose headquarters will be housed in the Center.

welded bridges

Winners of the $44,000 Bridge Design Competition, sponsored by U. S. Steel's American Bridge Division, were announced on Oct. 22. Photos of the winning designs will be published in the near future by WELDING ENGINEER. In the meantime, we feel that a note to the editors bears repeating here:

"Results of this competition turned up a number of welding applications which may be of interest to your readers. Many designs emphasized the strength of welded steel structures, plus the economy derived by prefabricating bridge sections."

Amen.

Russian jaunts

This department, having noted the travels to Russia of representatives from the welding industry, finds that this nation's growing interest in that country and its people forces many such visitors to the speaker's rostrum. For instance, when called upon by the National Welding Supply Association to give his impressions of the U.S.S.R., Jim Alcock of Saginaw Welding Supply Co., Saginaw, Mich., responded with an illustrated talk that was the highlight of the Central Zone meeting in Detroit. Jim tells us he has been booked around his home area for weeks to come.

Another recent visitor to the Soviet was Thomas D. Nast, president of All-State Welding Alloys Co., Inc., White Plains, N. Y. He, too, has already made several talks and undoubtedly will make more. Nast spent three weeks touring Russia, which, he said, has a great gap between research and production. Russian research in certain fields is tremendous, he told one audience, but there is at least a two-year lag before it can be implemented on a production basis.

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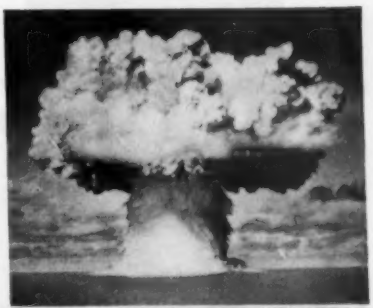

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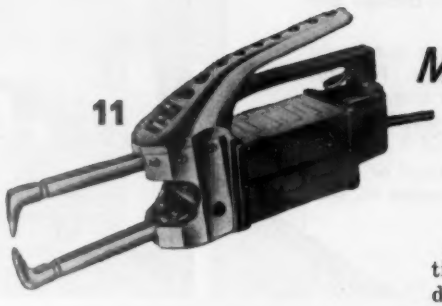

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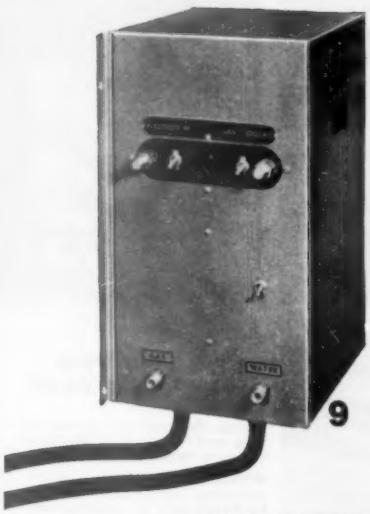

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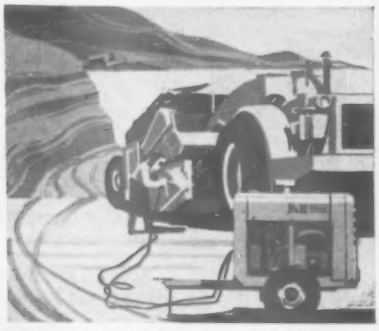

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WITH THANKSGIVING only a few weeks away, I wonder how many of us are really thankful we live in a country offering so many opportunities.

As Americans, we are indeed fortunate. We represent only about 7% of the world's population, and occupy only 6% of its land area—but we own 85% of the world's automobiles, 54% of the telephones, 83% of the TV sets, 48% of the radios, 46% of the electric power capacity, 30% of the world's railroad mileage and 35% of its improved highways.

Yet there are some among us who would change all this, trying to undermine our government, our way of life. And although only these few are deliberate in their attempts to destroy the liberties for which so many of us are thankful, others unwittingly join them.

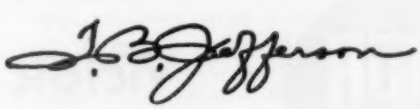
These are the ones who demand more "free" things—greater government benefits, more social security, higher pay without greater effort on their part—all the things they consider "part of our freedom." They forget government can give nothing, only take away and redistribute (and most inefficiently at that).

The gains we have made have not been because of a benevolent government. To a greater degree than in any other country, we have had opportunity of self-expression, self-development and advancement on a basis of merit.

Regardless of race, creed or class, it has been recognition of the individual as a responsible human being—free, self-controlling, capable of looking after himself—that has kept down the overhead of bureaucratic red tape and the cost of policing.

We should be thankful to the millions of people willing to work a little harder and spend a little less. Through them, Americans have been provided with more and better tools than any in the world, with a resulting higher output and higher wages.

We can be truly thankful that we have power tools, labor-saving devices and welding to provide a better way of life for all of us. Let's hope it is appreciated.



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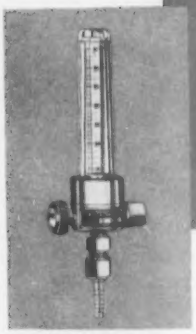

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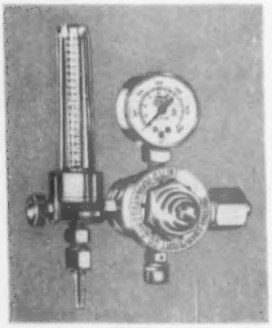

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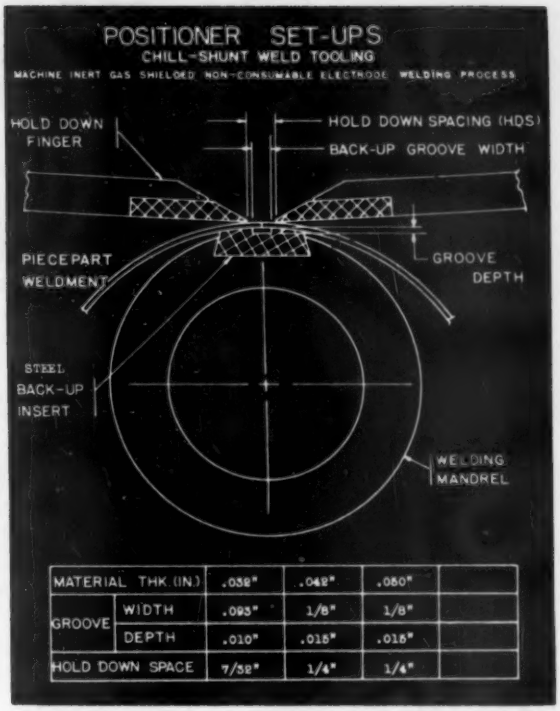
by **Harlan Meredith**
Airline Welding & Engineering
Hawthorne, Calif.

Specifications developed for production welding of thoriated magnesium



MATERIAL THK (IN.)		.032"	.042"	.060"	
GROOVE	WIDTH	.093"	1/8"	1/8"	
	DEPTH	.010"	.015"	.015"	
HOLD DOWN SPACE		7/32"	1/4"	1/4"	

PRODUCTION WELDING of new magnesium alloys, especially thoriated types designed for high temperature missile and aircraft service, has been aided by the recent development of specialized machinery and techniques.

For the past two years, these lightweight, high strength, crack resistant metals have been the subject of comprehensive pure research which has indicated that the materials have good weldability.

However, other questions—employment of good production welding processes and achievement of service requirements—remained unanswered. But the answers have been sought in the production research laboratories of Airline Welding and Engineering.

To serve as a guide for firms planning to process these alloys, we will describe techniques designed to production process magnesium-thorium HM21XA in three arbitrarily selected gages: 0.032, 0.040, 0.050. Test results substantiating the laboratories' findings are also given.

These studies indicate that production weldability of HM21XA is fair when comparing the mechanical properties of the gas-welded joint with the mechanical properties of the base metal. Ductility of the welded joint is very low: 1.5% elongation in 2 in. and only .03% in 0.500 in. However, weldability is good and ductility improved when the welded area has been roll planished.

Roll planishing is a continuous, localized and controllable cold working process, similar to the manufacture of wrought sheet, *i.e.*, by continuously rolling cast billets into strong ductile sheet stock. Roll planishing is used to continuously roll cast weld structures into smooth, level, stress-relieved weld joints.

In making tests, a heavy duty, Tig (tungsten inert gas) torch, variable speed cold wire feeder and 12 in. diameter welding wire spool assembly are mounted on a variable speed carriage riding a side-beam track. Power source is a 500 amp. a-c/d-c rectifier balanced wave welder equipped with continuous high frequency for arc stability and ease of starting.

To establish which parameters would result in welds with minimum porosity, the following were first selected:

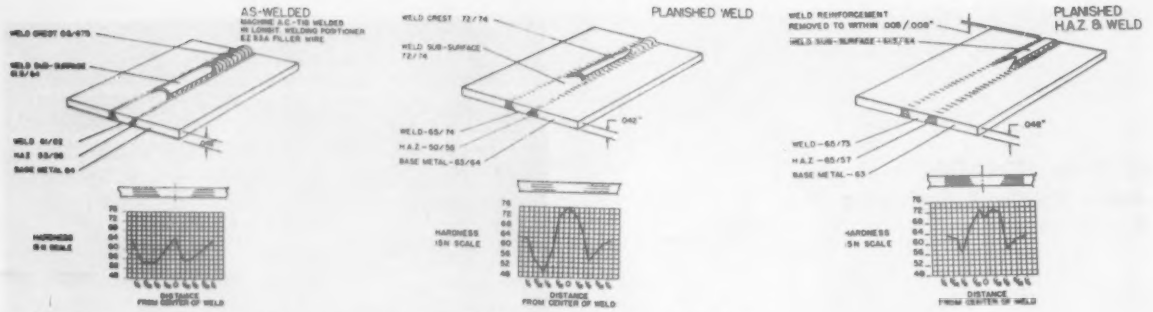
Travel speed	15 ipm	Arc length	3/64 in.
Wire feed rate	26 ipm	Arc voltage	18 VAC
Filler wire	EZ33A	WELDING CURRENT	
Filler wire diameter	3/64 in.	0.032	85 amp
Inert Gas	75% He, 25% A	0.040	115 amp
		0.050	140 amp

Various welding head travel speeds were the first and simplest of these parameters to be investigated. No special attempt was made to obtain porosity-free welds, since achieving this criteria under production conditions ordinarily is not economically feasible.

However, three panels of each gage were welded at 12, 15 and 16 ipm under production conditions, then radiographed. Only one panel contained any porosity, with only minor undercut, metal thinning and negligible surface pin holes evident at the root. This indicates that the base metal and filler wire could withstand a wide range of heat input without any ill-effect on sub-surface weld quality.

Most important of all parameters proved to be the choice of power supply and its use. The best type of current was d-c/s-p used with Tig welding where work is well-supported, positioned over a mandrel, and where chill-shunt tooling is used. Arc stability is further improved by using three phase rectification.

The d-c/s-p arc and heat input can be concentrated in a small area, while the a-c process produces a large,



DRAWINGS and graphs show how magnesium-thorium alloy HM21XA-T8 reacts when roll planished.

round, wobbling molten ball of tungsten which cannot be precisely controlled.

The concentrated arc allows the hold-down devices to be spaced closely together. Also, weld joint edges can be more closely gripped in juxtaposition, permitting the use of faster welding speeds. This eliminates piecepart preheating ahead of the arc and prevents any tendency for one joint edge to climb over the other.

The combination allows the use of a smaller back-up reinforcement geometry. If the casting technique is used, the depth of the groove can be limited to 0.005 to 0.010 in. If the suspension technique is preferred, then the groove depth should have a 0.040 in. minimum. The best shape of the back-up groove was found to be oval to combat the tendency of magnesium weld root drop-through deposit to sag.

When welding with d-c/s-p, less filler wire is needed than when using the a-c/h-f method. In the latter, the slow, wide arc column and h-f electron bombardment preheats the wire, which becomes limp and balls-up before reaching the weld puddle. Thus, the filler wire must be shoved into the arc at a fast rate to minimize this.

When using d-c/s-p, the confined heat of the compressed arc column and the higher welding speed made possible, combines to permit much slower wire feed without filler wire pre-heating and results in better control.

This advantage and the fact that d-c/s-p current transfer is more continuous, gives a smoother weld bead surface. Alternating current varies sinisoidally, reducing to zero at the beginning and end of each cycle, alternately heating the work piece as in d-c/s-p, then the tungsten electrode as in d-c/r-p, producing a severely rippled weld bead. This is an undesirable condition since magnesium alloys are extremely notch sensitive.

Mechanical properties of welded HM21XA-T8

Sheet thickness	Filler wire	TS	YP	% elongation (2.0 in.)	% elongation (0.5 in.)	Failure location
Weld reinforcement removed						
0.032 in.	EZ33A	31,400	22,300	1.5	0.03	HAZ
0.040 in.	EZ33A	31,300	21,900	2.5	0.05	HAZ
0.050 in.	EZ33A	30,700	21,400	1.6	0.03	HAZ
Weld roll planished, then reinforcement removed						
0.032 in.	EZ33A	32,500	20,300	1.5	0.03	HAZ
0.040 in.	EZ33A	31,900	19,300	2.0	0.04	HAZ
0.050 in.	EZ33A	30,100	21,400	1.6	0.03	HAZ
Weld reinforcement removed, then HAZ roll planished						
0.032 in.	EZ33A	—	—	—	—	—
0.040 in.	EZ33A	32,900	23,100	3.0	6.0	HAZ
0.050 in.	EZ33A	32,300	20,700	2.5	6.0	HAZ

One more advantage of d-c/s-p is the elimination of high frequency pock marks which occur when certain types of single phase a-c welders are used. The pock marks cause small craters along the weld edge and often contain minute star cracks which contribute to premature weld edge joint failure. High frequency is used with d-c/s-p only to start the arc.

Some disadvantages were determined, too: helium must be used to obtain optimum weld quality, and heavy magnesium oxide residue is deposited on the weld bead. However, this is easily removed with light wire brushing.

After determination of various parameters, exhaustive tests were performed. Seven test cylinders, 18 in. in diameter, were prepared from each of the three thicknesses, for a total of 21 vehicles. Each cylinder was made from two halves welded together using a square butt joint parallel with each cylinder axis. After welding, test vehicles were hot formed into different, more accurate shapes.

A series of tensile tests were first performed to determine the effect of scattered micro-porosity, weld edge undercutting and weld edge metal thinning of each gage. One welded panel from each gage was selected. Panels which contained the worst, medium and least sub-surface (determined by X-ray) and surface weld defect conditions were selected, and the related position of each sub-surface defect transferred to the weld panel.

Tensile coupons 1-in. wide were removed from the welded panels, assigned a code number and the defect noted. Weld crest and root reinforcement were removed to determine the true tensile strength of the weld joint as compared to the tensile strength of the base metal.

Of 30 tensile specimens, only two produced tensile values less than 25,000 psi. Specimens R16119-2A1-C and 2A3-A contained porosity. The -C specimen contained nine micro-pores less than 0.010 in. in diameter, and the -A specimen only one, 1/64-in. diameter pore. Both specimens contained excessive metal thinning at the weld edge.

How weld defects effect weld strength

Spec. No.	Defects: Visual	Defects: X-ray	X-ray No.	Mechanical properties: TS	Mechanical properties: YP (1,000 psi)	Mechanical properties: Elong.
(0.042 in. HM21XA-T8—as welded—weld reinforcement removed)						
A1	Undercut	1 tungsten	6117-7	31.2	22.3	2.5
A2	Undercut	none	6117-8	31.3	21.4	2.5
A3	Undercut	none	6117-9	31.3	20.0	2.5
C1	none	1 tungsten	6115-4	31.5	21.8	2.0
C2	none	1 micro-pore	6115-5	30.4	22.4	1.5
C3	none	none	6115-6	30.7	21.4	2.5
(0.040 in. HM21XA-T8—weld reinforcement removed—weld planished)						
A4	none	none	6117-10	32.8	19.1	2.5
A5	none	none	6117-11	32.4	18.9	2.0
A6	none	none	6117-12	30.3	19.7	1.5

INITIAL research showed that 0.042-in. thoriated magnesium HM21XA-T8 produced the best welds. The above table shows the effect of weld defects on weld joint strength. At right are additional ideal parameters determined:

Process	Tig (d-c/s-p)
Weld joint type	square butt
Joint preparation	square sheared and back beveled
Cleaning method	acetone solvent
POSITIONER SET-UP	
Hold down spacing	1/4 in.
Hold down pressure	40 psi
Back-up insert material	Steel
Back-up groove	Oval (1/64 in. deep, 1/8 in. wide)
WELDING CONDITIONS	
Welding current	100 for 0.042 in. 155 for 0.050 in.
Welding voltage	18
Inert gas	He—30 cfh
Polarity	d-c/s-p
Travel speed	21.5 ipm
Number of passes	1
Filler wire	HK31A
Filler wire diameter	3/64 in. for 0.042 1/16 in. for 0.050
Filler wire feed rate	33.5 ipm
Power supply	SR-200 WRLA & SCM-1
Tungsten diameter	1/8 in. tapered

In this same group, specimen R166110-2A2-B contained two micro-pores and two elongated, high density spots in the heat affected zone (HAZ). This specimen also had metal thinning at the weld edge. The tensile strength of the latter was 26,347 psi. All failures except one occurred in the HAZ. Specimen R16110-3C2-C failed in the weld, which contained one micro-pore, but tensile strength was very high: 30,414 psi.

Most of the tests indicated that failures occur predominantly in the HAZ because the greatest amount of deformation (during tensile loading) is in the area since it is softer, and the outer surfaces of the weld deposit are harder, than the base metal.

Transverse hardness tests were conducted to determine the as-welded gradient hardness from base metal to HAZ and HAZ to weld deposit. Superficial tests using 15N scale and 1/16 in. ball indentor, indicated a surface hardness for HM21XA-T8 sheet stock of 63/64. The hardness of the HAZ was found to vary from 55 to 56 near the weld edge. Weld hardness was 66/67.

It is axiomatic that a metal be considered ideally weldable if the joint behaves mechanically, metallurgically and physically the same as the parent metal. Since the room temperature tensile strength of T8 is 34,000 psi and the as-welded room temperature average tensile strength was 31,000 psi, it can be said joint efficiency is 91%. Conversely, the hardness efficiency is only 25%. These conditions place the weldability rating on a border line of fair to good mechanically.

Researchers tried to improve HAZ hardness, thinking weld joint efficiency would also increase. To do this, the weld and HAZ were moderately roll planished. Cylinders were planished in the as-welded condition, then, in order to have a direct comparison with the results of the previous tests, the weld crest and root reinforcement were also removed flush with the base metal.

Welds which received a planishing pass down the center had a hardness of 72/74 while HAZ hardness remained the same. Tests showed that planishing of the weld zone did not greatly improve mechanical properties or joint efficiency, but did indicate that, if the HAZ were so processed, an increase similar to that obtained in the weld center was possible.

Two weld samples were prepared for planishing by microshaving the weld bead and reinforcement to within approximately 0.005 in. of the base metal surface. Two sheet thicknesses were examined, 0.040 and 0.050.

Three-pass planishing was used, two passes made over the HAZ of the 0.042 gage, and a very light pass made over the center of the weld. HAZ hardness was 57/58 and the weld, 70/73. The 0.050-in. gage responded slightly better, the HAZ varying from 57 to 63.5 and the weld, 67 to 72.

In the as-welded condition, peak hardness always occurred at the center of the weld. In this condition, a sharp decline in hardness occurs from the weld center towards the weld edge with scattered hardness levels noticed in the HAZ.

Planished welds, however, show a sharp decline in hardness from the weld center toward the HAZ center. Apparently, planishing the weld only helps relieve shrinkage stresses within the HAZ, rendering the HAZ softer. On the other hand, HAZ planished welds had peak hardness along the weld edge.

The results of these studies show that the production weldability of magnesium alloys as compared to the weldability of aluminum alloys is very poor, but if the HAZ is cold worked by roll planishing, the comparison becomes much more favorable. At the present time, roll planishing techniques are being developed which show promise of producing an essentially flat hardness curve between base metal, through the HAZ and into the center of the weld.

Photo courtesy Baker Perkins, Inc.

The double edge sword . . .

Another view of stress relieving

by **Louis J. Larson**
Allis-Chalmers Mfg. Co.

AN IMPORTANT MANUFACTURING operation or a needless expense burden—stress relieving can be either, depending on whether its application is based on correct judgment or mere habit.

Through common usage, stress relieving of a mild steel weldment means heating it to a temperature between 1,100 and 1,200 F for an appropriate length of time. It does not include full annealing or normalizing.

However, this operation also produces certain other effects, so these should first be weighed to determine if they are real or marginal benefits.

The common benefits attributed to stress relief are:
(1) Improved corrosion and embrittlement resistance.
(2) Improved machinability and machining stability.
(3) Improved safety and service life.

The decision to stress relieve a particular weldment should be based solely on the benefits received in each particular case.

Stress relief to improve corrosion and embrittlement resistance is applicable to a relatively small portion of weldments. For many structures it is unnecessary, and for others, ineffective.

For example, carbon steel weldments are seldom subjected to corrosion since they are usually painted or protected by other means. On the other hand, when mild steel is used for chemical and oil equipment, some corrosion may occur, but stress relieving is not an effective preventative.

An important exception is the case of boiler or other equipment subjected to caustic embrittlement. Here stress relief is beneficial.

Stainless steels, *i.e.*, corrosion resistant steels, of both Cr and CrNi types are used for products ranging from those subject only to simple atmospheric attack to those able to resist severe corrosive media.

The Cr steels, particularly the air hardenable ones, are frequently heat-treated to reduce hardness; increase ductility and toughness. Treatment in the stress relief range of 1,100-1,200 F may be used, although a higher temperature is often better. However, their corrosion resistance is not appreciably improved.

From a corrosion standpoint, stress relief of CrNi steels is not beneficial, and may be harmful. Dairy and kitchen equipment, architectural trim and other applications involving mild corrosion use these steels and require no stress relief. Equipment subject to severe corrosion usually uses stabilized CrNi steels, and again weldments require no stress relief.

If unstabilized materials are used, corrosion will occur in a band adjacent to the weld and a heat-treatment after welding is necessary. However, it must be a solution treatment at high temperature, followed by reasonably rapid cooling.

Stress relieving at 1,100-1,200 F and slow cooling lowers the corrosion resistance of the entire surface of the steel to approximately that of the band next to the weld in the as-welded specimen.

Corrosion resistance of other material (nickel, copper, aluminum and their alloys) is not improved by any stress relieving operation.

When specifying stress relief to improve machinability, the object is usually to soften hard spots which make machining difficult. Weldments of air-hardening steels are prone to hard areas in and near the weld due to rapid

cooling. Heating to a stress relieving temperature is usually effective in reducing hardness.

But the usual mild steel grades used in weldments do not harden enough during welding to cause difficulty in machining, so heat-treatment is not necessary.

In some cases, stress relieving to insure machinability is a must, *e.g.*, welded machine tools and other equipment which must be held to a close tolerance and must remain accurate throughout their service life.

Conversely, there are weldments (portions of which must remain stable) for which stress relief is unnecessary because of weld geometry or location, *e.g.*, compressors built for the Manhattan Project at Oak Ridge.

These units were essentially spiral casings with a large flange opening at the center on one side. They were made in two halves, welded at the joint, around the outer periphery of the spiral. The flange to which the cover was bolted was welded to the casing with a circular joint.

The flange face had to remain true and flat after machining and during service since the gaskets between cover and flange were solid aluminum wires. No packing of any type was permissible. Although the importance of flange stability was fully realized, it was decided not to stress relieve.

The decision was based on two factors. First, and most important, no harmful distortion was expected during or after machining. Although the weld in the outer spiral was non-symmetrical, it was a good distance from the flange and would, therefore, cause no distortion of the critical area.

The weld around the flange was adjacent to the critical area, but was symmetrical so the required machining would not result in unbalanced welding stresses. Consequently, there was no apparent reason for flange distortion or waving.

A second important consideration, from a manufacturing standpoint, was the added cost of stress relief. For the scheduled 40 units per day, one or possibly two latest design furnaces would have been required. Shop room was at a premium, and to have erected the furnaces elsewhere would have required additional handling, etc.

No difficulty from distortion during machining was observed, and after a considerable number of years, there have been no complaints or reports of distortion. Thus, omitting the stress relief resulted in substantial savings in capital investment and operating costs.

The strongest reason for stress relief is to insure against premature failure by brittle fracture. Assuming residual stresses contribute to this failure, stress relief is logically used to remove them.

Under some conditions, residual stress causes early failure, but in many structures is not harmful. Thus, stress relieving is frequently specified because of a lack of definite information.

In one case a manufacturer stress relieved certain welded equipment because it was thought necessary to prevent field failure. This continued for years until one engineer questioned its actual necessity.

He decided to omit stress relief on smaller units. When there were no field failures, he decided to omit it on larger sizes, and they, too, were satisfactory. In this case, stress relief was an unnecessary expense incurred largely because of insufficient information.

The effect of stress relief on structure safety should be evaluated with the various possible ways of failure in mind, *e.g.*, exceeding ultimate material strength, repeated stress, brittle fracture.

Residual stresses are not harmful to static ultimate strength except in cases where conditions are conducive to brittle fracture. Laboratory investigations have shown stress relieved structures may actually be weaker. (Tests on cylinders with circular butt-joints showed non-stress relieved specimens to have 5 to 10% higher strengths.)

This is easily explained. Forming operations cause a certain amount of cold work, sufficient to increase material strength. Also, as-deposited weld metal is partially quenched, and both weld metal and the adjacent base metal may be slightly hardened and strengthened due to welding heat.

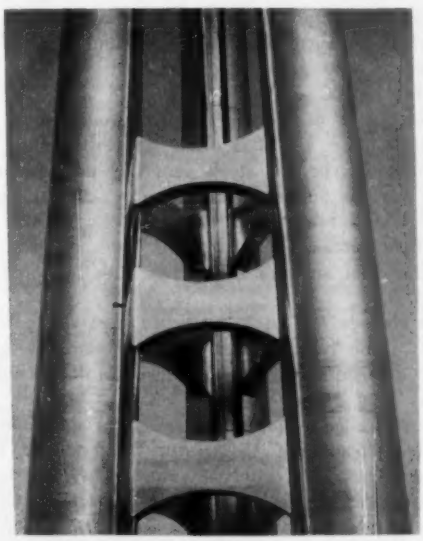
When the structure is stress relieved, the temperature to which it is heated is sufficient to partially anneal or draw the hardened material, resulting in a lower ultimate material strength.

As for residual stresses affecting fatigue resistance, evidence is not conclusive. Most investigators have shown that residual stresses do not produce significant effects for several reasons.

When the first cycle of alternating stresses is applied, tensile stress due to applied load is added algebraically to the residual stress. The ultimate sum of the stresses is the tensile yield point. And although application of additional load causes plastic flow, it does not increase the maximum tensile stress.

After the load is removed, tensile stress decreases and the remaining residual stress on the unloaded specimen will only be the difference between yield point strength and tensile stress due to the applied load.

Thus, application of alternating stress reduces residual



CHROME-nickel steels subjected to only mild atmospheric corrosion require no stress relief since it may be harmful rather than helpful in improving corrosion resistance.

STRESS relief, from a safety standpoint, is limited primarily to structures of the usual commercial steels operating at temperatures at or below room temperatures.

tensile stress and, consequently, residual stresses have little effect on specimen fatigue strength. The greater the stress due to applied alternating load, the less is the effect of the residual stress.

Resistance to brittle fracture is greatly affected by residual stresses, however, and stress relief is important for structures subject to this type failure.

Stress relieving of welded structures was originally initiated to eliminate welding stresses so as to prevent brittle failures. However, residual stresses are not the only factors involved in brittle fracture.

A theory quite popular presently is that brittle fracture occurs only when three conditions co-exist:

(1) Material must be in notch brittle condition;

(2) There must be a crack, notch or some type of defect in the structure;

(3) There must be high residual stresses in the region of the notch.

Removing any one condition eliminates the danger of brittle fracture. Thus, high residual stresses become dangerous only if the material is brittle and has a crack or other defect.

Choosing a non-brittle material would seem to be a simple solution, but it is often not easily done.

Common structural steels generally used become brittle at various temperatures (usually ranging from 0 to 100 F) and many engineering structures are exposed to temperatures in this range or lower. Therefore, it is probable that steel in these structures is notch brittle.

To choose the most suitable steel would require a test of some type, but as yet no commonly-agreed-on test to determine whether a material is dangerously brittle has been developed.

There are many laboratory tests for determining the so-called "transition temperature" of steels, but the different tests give different values. There is no insurance as to which, if any, of these is a true criterion for the temperature at which brittle failure may occur.

Special steels are available which have transition temperatures below most operating temperatures, but these are too costly for general use. Thus, selection of a suitable steel presents a difficult problem.

For structures operating at elevated or moderately warm temperatures, it is reasonably certain that available commercial steels will not be brittle. There is no danger of brittle fracture at operating temperatures for these structures even if no stress relief is used and residual stresses are present.

If stress relieving is omitted, proper precautions will be necessary during fabrication, erection and shutdowns. These include assuring the structure is not subject to high stresses when its temperature is below that specified. It may well be both cheaper and easier to take these precautions than to thermally stress relieve.

The effectiveness of preventing brittle fracture by eliminating all cracks and defects (the second condition specified above) is questionable.

While in most brittle fractures the defect causing failure has been obvious, in some cases it has been almost impossible to identify, and would probably not be detected even with the most modern inspection method.

However, some large field-welded projects, relying on thorough inspection methods, have been successfully completed and put into service. In these, all defects were repaired and the weldment surfaces carefully ground to eliminate any surface notches or defects.

Although this method has been successful at times, it is not considered sufficiently reliable to be effective in all cases.

As stated previously, to insure against low-stress brittle fracture by using special steels may be too expensive; to insure against failure by eliminating all defects is too uncertain. The remaining possibility is to eliminate the residual stresses.

Service performances indicate the reduction in residual stresses obtained by heating weldments to 1,100-1,200 F for an appropriate time is sufficient to prevent brittle fracture.

Weldments, shop fabricated within shipping limits, can usually be heat-treated in a furnace, and when possible, may be the least costly method of eliminating low-stress brittle fracture. As a consequence, thermal stress relieving has been adopted widely as a safety measure.

Strictly from a safety standpoint, the absolute need for stress relief is limited primarily to structures of the usual commercial steels, operating at temperatures at or below normal room temperatures. At high temperatures, common steels are safe without any stress relief.

Many low-alloy steels having a low transition temperature (austenitic stainless steels, nickel alloys, and most non-ferrous alloys) are not subject to low-stress brittle fracture, and thus, do not require stress relief to insure safety.

For a few alloys and weld metal deposited by some electrodes, stress relief is actually harmful. The E12016 electrodes of NiMoV analysis show temper embrittlement after heating at normal stress relieving temperatures. This is significant when welding T-1 steel.

If the NiMoV electrodes are used for welding this steel, the weldment should not be stress relieved. If for some reason it must be stress relieved, another type electrode (usually of lower tensile strength) should be specified.

This is the concluding article of a two part series begun in the September WELDING ENGINEER.

Spot welding procedures and design

by **Lester F. Spencer** . . . *Metallurgical Engineer*

SPOT WELDING RESULTS are largely a function of weld design, the weld cycle used and the material welded—all three factors being interdependent.

Spot welded structures are usually designed so that welds are loaded in shear and, as a result, tension shear strengths are used for evaluation. The direct tensile strength value will be less than the shear strength in ductile welds, whereas, it will be considerably less in non-heat-treated welds in hardenable materials.

Frequently, the ratio of direct tensile strength to the tension shear strength is taken as an indication of weld ductility. Thus, spot welds of a hardenable material will be weak in direct tension when the weld structure has not been tempered. However, this relatively brittle weld may be made more ductile by use of automatic tempering within the weld cycle.

Many factors contribute to formation of a spot weld, and, where experience is either little or none at all, coordination of these factors to produce a consistently good weld may be quite time consuming. A basis for decision may be obtained by using data in recommended practices as given by AWS and RWMA; these values representing average conditions. Another excellent source is data from suppliers and manufacturers.

Since a variety of factors influence spot weld characteristics, it is reasonable to expect some variation in weld strength. An adverse change in a single factor may not appreciably change weld strength. However, a simultaneous change in a number of these factors may weaken the weld considerably.

In the case of aluminum-base alloys where good operating practices are used, this strength variation should not be more than $\pm 10\%$ of the total average of 21 out of 25 consecutive welds, and the remaining four should show a variation not over 20%.

Good inspection and control system is essential to judge both quality and consistency of results in spot welding. In addition, appropriate action is necessary when quality falls below a pre-set standard.

One method commonly used to determine weld strength in a quantitative manner is examination of a weld nugget's symmetry, diameter and penetration.

Welds should be symmetrical about the plane of the faying surfaces. Weld size, which will vary with the material joined, should be about three times the thickness of the thinnest outside piece plus 0.06 in. Weld penetration is the depth at which the fusion zone extends into the outside pieces, and is expressed as a percentage of the outside piece thickness.

Normally, minimum depth generally accepted as standard is 20% of the outside sheet's thickness. Penetrations less than this will result in a "cold weld" *i.e.*, weld strength below minimum requirements, or even zero.

The upper limit for weld penetration has been given as 80% of the outside sheet's thickness. If weld penetration is above this value, a condition exists which will result in low electrode life, and, in the case of aluminum and magnesium-base alloys, severely cracked welds.

Visual spot weld inspections, if carefully made, will detect defects within the weld area such as cracked or porous welds, surface indentations, electrode pick-up, sheet separation, weld metal expulsion, distortion, surface burning, spitting or spattering and weld nugget distortion.

Cracked welds are a result of overheating, improperly applied load during welding or improperly used schedules when welding crack-sensitive material.

An obvious danger is crack propagation leading to ultimate structure failure, particularly with "quench cracks" occurring on weld periphery, since these occur

in the zone of highest stress.

These cracks, characteristic of crack-sensitive material or material combinations, may be eliminated by use of a spot welding schedule that includes preheat and temper stages. Pulsation welding may also be used, as well as a tailing slope control after welding.

The temper stage, obtained by an additional pulse of power at lower current, will spread the heat over a larger area so that shrinkage stresses will not be greatly localized. The typical "crow's foot" cracking in the center of the weld frequently has little significance on weld properties. However, elimination may be realized by use of high unit pressures to forge the weld during nugget solidification.

In the aluminum alloys, severe cracking (those extending from the weld metal proper or to the surface of the sheets joined) appears to reduce both corrosion resistance and fatigue strength of the joint. But this effect is considered cumulatively, and their presence in small quantities should not endanger structure performance.

As a result, such defective spot welds are generally tolerated to about 3% on structural parts; 6% on non-structural assemblies. Similarly, longitudinal cracks in the joint plane classifies the weld as defective if they extend more than 20% of the weld diameter.

Magnesium alloy MIA as usually not susceptible to cracking, whereas, alloy types AZ31A and AZ61A may crack if improper welding conditions are used, or where the surface has not been cleaned properly. In these alloys, radial cracking may be eliminated by increasing welding pressure, decreasing welding current, increasing both pressure and current, or increasing the electrode radius as well as pressure and current. In some cases, a more thorough cleaning of the material is all that is needed.

Porosity is found to some extent in all welds, and has little influence on weld properties since applied stresses are confined to the periphery of the welds. This defect is considered a result of overheating, inadequate pressure, premature release of an adequate pressure, or a too-late application of adequate forging pressure.

With nickel and high-nickel alloys, porosity from 5 to 10% is usually realized. An adverse effect on mechanical properties occurs only where the porous area is large with respect to the weld, or when the defect has sharp, irregular outlines.

In the aluminum alloys, permissible porosity is defined as the presence of one or more cavities whose dimensions in any one direction do not exceed 20% of the thickness of the thickest sheet joined, or 10% of the total thickness, whichever is largest.

Porosity may often be eliminated or reduced by using lower rates of heat build-up, less maximum temperatures and higher pressures. Since lack of cleanliness and expulsion may also contribute to porosity, it may be well to investigate the efficiency of the cleaning cycle. Should porosity-prone combinations of dissimilar materials be spot welded, experimental work may be required to determine correct machine settings to minimize porosity.

Excessive indentation not only mars surface appearance, but, as in the case of aluminum alloys, may also affect part separation or fit. This defect is frequently traced to either a too-long welding time, excessive machine pressure, or weld metal expulsion.

Zero indentation is difficult to obtain since it is partially caused by nugget shrinkage. In nickel and high-nickel alloys, maximum allowable indentation is 5% of the total thickness.

In the aluminum alloys, welds are considered unsatisfactory if surface indentation is 20% of the thickness welded where most of the indentation is confined to one side, or 10% if it is approximately equal on both sides. In addition, if indentation is due to a too-soft temper, material specifications need only be changed.

In general, indentation may be minimized by decreasing welding time, decreasing welding pressure (but only when this factor is at an excessive value), eliminating expulsion by using a flat-faced electrode on the more important side, or by using a projection welding technique.

Use of a flat electrode on one side of the assembly and a contoured electrode on the other is a common procedure. However, there may be limitations, *e.g.*, spot welding of the magnesium alloys, where electrode indentation is recognized as a function of electrode tip contour, pressure and current.

Up to gages of 0.064 in., a flat tip is recommended for the outside surface of the part being welded. In heavier sheet, a flat tip may result in uneven penetration. To avoid this condition, indentation is corrected by increasing contact areas of both tips.

Electrode pick-up is normally a function of material and is frequently associated with improper surface conditions, inadequate cooling of electrode tips, poor electrode design, excessively high energy levels, electrode deflection, improper machine operation and low tip force.

In magnesium alloys, pick-up is reduced by adequate cleaning of the surface and proper electrode cooling to

SPOT WELDING was used to join the internal components of a magnesium oil tank to the tank shell. Fittings and shell joints were torch-welded.

reduce surface heat. In the latter, cooling should not permit condensation of moisture on the tips. Water should be supplied to the electrodes only during the welding operation by a solenoid valve and time relay actuated by the welder control.

Within a general classification (such as these magnesium alloys) tip life depends on the alloy type, as well as the previously mentioned factors of surface preparation, electrode cooling and current. Thus, while alloy M1A permits successive welding of about 25 spots before tip cleaning is required, AZ31A will permit the welding of 100 to 200 consistently sound welds.

With the exception of welding coated materials, surface melting is frequently associated with electrode pick-up, resulting from insufficient pressure, insufficient time with excessive current, or a combination of both. The use of inadequate electrode cooling and inadequate squeeze and hold times also contributes to this defect.

Another associated defect is sheet separation. Its cause is similar to that for electrode pick-up. In the aluminum alloys, sheet separation may be reduced by increasing tip radius. Although sheet separation is more difficult to control in the softer tempers, a suggested limitation when welding two equal gages of aluminum is not to exceed 10% of the sheet thickness.

Distortion, which may be measured by sectioning and measuring the gap width between the sheets, may be caused by excessive indentation, metal expulsion from the interface, misalignment of electrodes or excessive welder arm deflection, original malformation of the pieces welded, improper clamping, or poor fixturing.

Since distortion-free welds is a basic premise on which resistance welding is chosen as a joining process, reasons for physical distortion should be immediately traced and corrected. Faulty jigging, electrode alignment, material design or even the technique employed should all be investigated.

Interfacial expulsion is frequently caused by overheating, particularly when combined with inadequate pressures or steeply faced electrodes. Other probable causes would include welding too near an edge, improper cleaning of weld surface, or using a portion of the available part-forming pressure to obtain alignment. Expulsion normally results in internal cavitation which, in turn, seriously reduces weld strength.

To eliminate this defect, use a wider flange, being careful of fit between parts; decrease the current or increase the pressure; and carefully clean the parts welded. In some cases, slope control has also been helpful in eliminating expulsion in difficult cases where ordinary procedures cannot be used. In actual practice, a general rule is to apply a current value so that expulsion is avoided, with the resulting weld having a maximum shear strength for the force-time-electrode conditions employed.

At times, when welding magnesium alloys, an increase in electrode radius, as well as increased pressure and current values, will prevent expulsion.

Upper and lower arms of a spot welder must be rigid enough to minimize deflection of electrode tips. Excessive deflection will cause inconsistent spot strengths, irregular shaped welds, expulsion, cracking, excessive pick-up and misalignment of parts being welded.

With the magnesium alloys, if welds are appreciably misplaced, subsequent welds may require use of a smaller electrode against the side with the least penetration. On the other hand, it may be necessary to either clean the electrodes with fine abrasive cloth more frequently, or clean the material more carefully.

Should the spot diameter within a structure be inconsistent, (*i.e.*, a small diameter spot adjacent to a relatively larger one), a shunting effect has probably proceeded from the smaller to the larger diameter spot.

Thus, it is possible that shear strength of the smaller will be less than specification. If the spot weld is adjacent, but not too close to a larger diameter spot, inconsistent welding controls or procedures may be at fault.

At times either a mis-shaped or misplaced nugget is obtained. A mis-shaped nugget is ordinarily caused in high strength materials by mis-shaped or misaligned electrodes, or electrodes with too much tip radius. This defect can be corrected by machine cutting electrodes to recommended contour, and maintaining this shape with contoured dressing tools.

A misplaced nugget, when welding high-strength materials such as high-nickel alloys, may be caused by welding dissimilar thicknesses of the same material, welding of some dissimilar metal combinations, by choosing electrode size or material poorly, or by a combination of these factors.

In conclusion, then, a weld structure exhibiting low strength may be a result of a too-small weld for the welded sheet thickness, an incomplete fusion between the welded sheets, or one or more of the defects discussed above.

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by **G. E. Linnert**
Welding metallurgist
Armco Steel Corp.

Procedures for welding 17-4 PH stainless steel

STAINLESS STEEL is definitely a wonder metal of our time—not only because of its strength, toughness and corrosion resistance, but because these properties are retained over a wide temperature range.

One such stainless steel, which has demonstrated very satisfactory weldability under production welding conditions, is Armco's 17-4 PH. It is being used in a variety of welded assemblies employing stainless sections ranging from minute machined-fittings to heavy members prepared from blooms, bars or forgings.

Sound joints can be easily produced in 17-4 PH by proper welding practice; and properties comparable to those of the parent metal can be obtained by postheat treatment.

Welding procedures are more like those ordinarily applied to austenitic Cr-Ni grades, even though 17-4 PH composition is different and its structure more closely resembles a martensitic stainless. (Any arc or resistance welding methods used on regular grade stainless are applicable to 17-4 PH.)

A favorable chemical composition accounts for 17-4 PH's good welding performance. Copper present in the alloy does not adversely effect welding behavior, and the small quantity of columbium customarily present plays no significant part and requires no special attention.

Low carbon content is also an important feature. It restricts hardness of rapidly cooled material and prevents crack formation in weld metal and heat-affected zone, eliminating preheating.

Although base metal shows no susceptibility to spontaneous underbead cracking from weld hardening, it does not possess the high ductility and toughness of austenitic Cr-Ni steels. Thus, it should not be subjected to unnecessary notch effects which might initiate cracking.

Weldment design should be given the same consideration as for any other high-strength alloy-steel to avoid concentration of residual welding stress or reaction stress at square corners, unfused notches and sharp threads.

Weld metal of 17-4 PH composition is used when mechanical properties comparable to those of the base metal are desired. Simple fusion of base metal is adequate, but a W 17-4 PH filler wire or electrode is preferable. The latter provides weld composition held to the high side of the alloy's chromium and nickel ranges to insure good weld metal ductility in the highly hardened condition.

For close control of weld composition, use Vee or U-joint preparations that permit additions of W 17-4 PH filler metal from coated electrodes or bare wire. Deep penetration should be avoided since heavy weld dilution results and tends to shift weld composition away from that of the filler.

Microstructure of W 17-4 PH weld metal at room temperature consists of a small amount of delta or free ferrite in a martensite-like matrix. Presence of delta ferrite is helpful in maintaining a high immunity to

Deposited by covered 17-4 PH electrodes[1]

Average weld metal analysis							Range of values and average	Mechanical properties U.T.S. psi	0.2% YS psi	Elong. % in 2 in.	Red. of area	Hardness Rockwell C
C	Mn	Si	Cr	Ni	Cu	Cb						
0.043	0.48	0.28	16.71	4.82	3.55	0.18	Max.	198,000	172,000	14.0	37.0	44
							Min.	183,000	152,000	9.0	12.0	42
							Avg.	190,000	164,500	11.4	27.9	44
Deposited by Mig process[2]												
0.032	0.44	0.43	16.83	4.87	3.52	0.19	Max.	203,000	179,000	13.0	43.0	44
							Min.	179,000	166,000	7.5	16.0	43
							Avg.	195,500	173,500	9.6	25.0	44

(1) Three heats tested; six tensile specimens.
(2) Five heats tested; eight tensile specimens.
All specimens treated 1,900 F, ½ hour, air cooled to 60 F for 1 hour plus 900 F, 1 hour, air cool.

TABLE I—Tensile properties of all-weld-metal specimens of 17-4 PH (0.505 in.) prepared by manual deposition per specifications of AWS covering multi-layer deposits.

hot cracking. However, a minimum amount is desired in the final heat-treated weld metal structure to obtain good ductility in a hardened state.

Delta ferrite content is dictated primarily by chemical composition; or, from a practical standpoint, chromium and nickel content. Higher chromium content increases the amount of delta ferrite, while higher nickel content decreases it. Postweld solution treating is also important in ferrite reduction. (Mechanical properties of solution treated and hardened weld metal are given in table 1.)

Austenitic Cr-Ni stainless weld metal may be used for joining 17-4 PH when high-strength weld joints are not needed. This filler metal provides a tough, ductile deposit, but strength is only 90,000 psi ultimate tensile and 60,000 psi 0.2% yield strength.

A 308 filler metal would be satisfactory. However, if the weldment is to be given a postweld precipitation hardening treatment above 1,000 F, then 308L or 347 filler should be used to avoid sensitization from carbide precipitation.

If the weld metal is to join 17-4 PH to a dissimilar metal, dilution must be considered, *e.g.*, welding 17-4 PH to a plain-carbon or low-alloy steel, a 309 filler metal should be used; if postweld treatment involves heating in the sensitizing temperature range, a 309 Cb filler metal might be advisable.

Metal-arc welding practice for 17-4 PH does not differ from that for standard stainless grades. Coated electrodes of W 17-4 PH grade should be deposited with the proper technique prescribed for stainless electrodes because weld metal response to subsequent precipitation hardening heat-treatment is critically controlled by chemical composition.

Chromium loss by oxidation in a too long arc gap, or a pickup of carbon from base metal surface contamination are examples of poor practice easily affecting the properties of heat-treated weld metal.

Tables 2 and 3 present data on the mechanical properties of metal-arc welded joints in a 1-in.-thick section. In conducting these weld tests, the following standard conditions were incorporated in the procedure:

(1) No preheating was applied.

(2) Approximate interpass temperature was 60 to 300 F.

(3) Base metal pieces were securely clamped to a 1½-in.-thick strong-back.

(4) Base metal was in Condition A before welding unless otherwise noted.

(5) Welded assemblies were permitted to cool to room temperature before postweld heat-treatment.

Table 2 contains tensile test data on joints in 1-in. thick bars subjected to a variety of postweld treatments. The influence of varying the hardening temperature from 900 to 1,200 F, is illustrated for both the welded, and welded and annealed conditions. Note that because the W 17-4 PH weld is a richer composition, sub-zero cooling after solution treatment increases weld metal tensile and yield strengths after hardening.

Table 3 contains impact and hardness data for joints in 1-in.-thick bars postweld treated in the same manner as those in table 2. Weld metal subjected to a postweld hardening temperature of 1,100 F and above displays a significantly lower impact strength, possibly because of austenite reformation at these higher temperatures.

A postweld solution treatment, however, homogenizes weld structure and results in substantial impact strength improvement when finally hardened at 1,100 F and above.

Welding heavy or rigid sections usually imposes higher-than-normal stresses on the weldment. To demonstrate 17-4 PH performance under more rigorous arc-welding conditions, "torture tests" were conducted.

Highly-restrained circular-groove weld tests disclosed no susceptibility to spontaneous cracking in the heat-affected base metal zone. Results from a maltese-cross design specimen revealed slight cracking susceptibility in grooves under high transverse stress concentration.

Although use of a higher interpass temperature would possibly have prevented cracking, as in other steels, cracking susceptibility was overcome by a homogenizing heat-treatment (2,150 F, air-cooled 1 hour) before regular solution treatment, or by placing the material in the overaged con-

Final condition prior to testing	Tensile properties* Ult. Tens. Str., psi	0.2% Yld. Str., psi	Elong. % in 2 in.	Red. of area %	Location of fracture
As-Welded	140,000	96,000	4.5	10.5	Weld Metal
Welded + 900 F, 1 hr., air cool	158,000	118,000	8.0	21.0	Weld Metal
Welded + 1,000 F, 1 hr., air cool	155,000	108,000	9.5	27.0	Weld Metal
Welded + 1,100 F, 1 hr., air cool	158,000	111,000	7.5	18.5	Weld Metal
Welded + 1,200 F, 1 hr., air cool	143,000	105,000	15.0	52.0	Base Metal
Welded + solution treated	145,000	91,000	10.0	46.5	Base Metal
Welded + solution treated + 900 F, 1 hr., air cool	186,000	163,000	9.5	36.0	Weld Metal
Welded + solution treated + 1,000 F, 1 hr., air cool	167,000	146,000	9.5	39.0	Weld Metal
Welded + solution treated + 1,100 F, 1 hr., air cool	158,000	129,000	11.0	38.0	Weld Metal
Welded + solution treated + 1,200 F, 1 hr., air cool	143,000	100,000	14.0	54.0	Base Metal
Welded + solution treated + —110 F for 1 hr. + 900 F, 1 hr., air cool	201,000	178,000	10.0	34.0	Weld Metal

*Tensile test values are averages from two specimens.
All solution treatments were at 1,900 F, ½ hr., air cool to 60 F for 1 hour.
(Note effect of subzero cooling on tensile and yield strengths)*

TABLE 2—Tensile properties of metal-arc welded joints in 1-in. thick flat bars. Single 45 deg bevel butt-joints with 3/8-in. root opening and permanent back-up were manually welded with 5/32-in. covered 17-4 PH electrodes. Standard 0.505 in. tensile specimens were taken transverse to weld axis.

dition (1,150 F, air-cooled 4 hours) before welding.

When Tig welding, no change is required in welding procedure for standard grades. A W 17-4 PH filler rod should be added to the joint whenever possible to obtain a optimum composition deposit.

An austenitic Cr-Ni filler may be used to produce a tough, ductile (but not precipitation hardenable) weld deposit. Argon or helium can be used for shielding, and with either gas, copper in the alloy is recovered completely.

(Mig welding has been used to only a small extent on 17-4 PH grades; yet it can be applied with the same facility as any other stainless.)

Resistance welding processes regularly used on stainless are successful with 17-4 PH. In resistance butt-welding, the flash-butt method is preferred over upset-butt.

When fabricating high-strength wire articles (*e.g.*, radar antenna) strong cross-wire joints can be produced by projection welding. Highest joint strength is gained when wire is hardened before welding, eliminating joint hardening.

In simple 17-4 PH weldments, where single-pass weld joints are used, a regular postweld hardening heat-treatment can be applied to eliminate the heat-affected zones and produce full hardness throughout. When heat is applied locally during welding, a zone immediately adjacent to the weld becomes austenitized. Cooling to room temperature, it transforms to martensite.

Hardness of this adjacent zone is about Rockwell 30-35 C, or roughly equal to annealed material. Base metal just beyond this annealed zone is subjected to a temperature range that may cause hardening, depending on structural condition before welding.

Ordinarily the time at welding temperature is relatively short for a precipitation hardening heat-treatment. Therefore, increased hardness is very small, even when the weld is made in annealed base metal.

When the welded assembly is subsequently heated to a selected hardening temperature, both heat-affected areas and unaffected annealed base metal are precipitation hardened to essentially the same level. In heavy weldments where multipass weld joints are used, response of heat-affected areas may not be entirely uniform because of structural alterations caused by successive heating from more than one bead.

In many cases application requirements will permit the small property variations encountered in a two or three pass joint that has been given a postweld hardening treatment.

As-deposited 17-4 PH weld metal also responds to precipitation hardening heat-treatment. The fast rate of cooling from welding temperature places the deposit in a condition similar to that of annealed material. A single weld bead of 17-4 PH as deposited has a hardness of Rockwell 30-35 C, which will increase to 40-45 C after the 900 F hardening treatment.

In multipass weld deposits, repeated heating from successive beads may leave a structure variation from bead to bead, prohibiting uniform response to precipitation hardening treatment. An annealing treatment applied to the weldment before hardening will remove these variations and insure uniform mechanical properties. Annealed weldments should be cooled to 60 F or lower to insure transformation in the richer-alloy weld metal.

Torch cutting 17-4 PH requires a method suited to stainless steel, such as flux-injection, powder-cutting, oxy-arc, or air-arc. Since the heat-affected zones of 17-4 PH are not significantly hardened or embrittled by localized heat from welding or cutting, many bars up to 1-in. thick have been torch cut by the flux-injection method with excellent results.

Cutting tests with iron-powder cutting were carried out on sections of round bars as large as 9 in. in diameter without difficulty.

Corrosion resistance of 17-4 PH weld metal is comparable to 17-4 PH wrought material. Consequently, weldments have proved very satisfactory under corrosive service conditions. It must be noted, however, that the heat effect of welding can influence corrosion resistance of the base metal in a zone immediately adjacent to the weld.

This zone can display some susceptibility to accelerated intergranular attack to corrosive hot acid solutions. The sensitivity to attack is present as welded. Application of a postweld hardening treatment in the 900-1, 150 F temperature range does not alter susceptibility, but a postweld annealing treatment before the hardening treatment will completely eliminate sensitivity.

Final condition prior to testing	Standard Izod impact, ft.-lbs.* Notch in top of weld metal	Notch in transverse face of weld metal	Hardness Rockwell "C" Weld metal	Base metal
As-Welded	36	39	22	32
Welded + 900 F	21	28	32	44
Welded + 1,000 F	30	34	30	40
Welded + 1,100 F	10	9	35	36
Welded + 1,200 F	8	7	34	32
Welded + solution treated	14	16	35	33
Welded + solution treated + 900 F	9	6	44	44
Welded + solution treated + 1,000 F	16	17	39	41
Welded + solution treated + 1,100 F	22	22	34	37
Welded + solution treated + 1,200 F	26	26	32	32
Welded + solution treated + —110 F for 1 hr. + 900 F	12	11	43	43

*Izod values are result of single tests.
All solution treatments were at 1,900 F, ½ hr., air cool to 60 F for 1 hr.
(Note: Where hardened at 1,100/1,200 F, a post weld solution treatment prior to hardening increases weld impact strength significantly.)

TABLE 3—Impact properties and hardness data for arc-welded joints in 1-in. thick flat bars. Single 45 deg bevel butt-joints with 3/8-in. root opening and permanent back-up were manually arc-welded with 5/32-in. covered 17-4 PH electrodes. Standard Izod impact specimens were taken transverse to weld axis.

Hardfacing alloys increase life of manganese steel products

WORK-HARDENED MANGANESE STEEL is widely used in heavy industry because it resists metal to metal wear.

As durable as the metal is, its strength can be further bolstered by applying a hardfacing alloy. Hardfacing procedures can also be used to repair worn items, such as sprockets and pinions of manganese steel.

Manganese steel containing from 10 to 14% manganese and 1 to 1.4% carbon is austenitic when water quenched from about 1,850 F. Its hardness, as quenched, is about 210 Brinell (RC 16), but upon work-hardening, the hardness will increase to as high as 550 Brinell (RC 56).

Internal stresses from quenching and the reduction of mechanical properties at the center of heavy castings have limited the practical maximum section thickness to about 5 or 6 in. Stresses that develop during cooling of the mold often crack it prior to heat treatment.

The relatively high austenitizing temperature (1,850 F) plus the high carbon content may cause some decarburization and loss of manganese at the surface. This forms a martensitic skin which is more brittle than the underlying metal and is liable to crack—which could cause failure of critically loaded thin section parts.

Before hardfacing or fixing worn manganese steel parts, all layers of martensite or work-hardened material must be removed. Work-hardened manganese steel embrittles rapidly upon reheating due to the formation of a precipitated carbide.

It is best if this layer is ground off, or, if possible, the part should be heat treated at 1,850 F, followed by a water quench. This will re-austenitize the manganese steel and remove the effects of work-hardening, also making the steel non-magnetic.

Wall Colmonoy Corp., Detroit, produces two hardfacing alloys that can be used on manganese steel. A manganese steel electrode, conforming to AWS specification EFeMn-A (Walmang No. 3), consists of a mild steel rod coated with a nickel and manganese alloy containing necessary stabilizers, fluxes, etc.

The following d-c amp settings are recommended for use with the various electrode diameters: 1/8 in., 50-70; 5/32, 70-100; 3/16, 100-140; 1/4, 140-175. Using the electrodes at these settings will leave a deposit having a hardness of about RC 20, which will harden as high as RC 54.

The second material, conforming to AWS specification EFeMn-B bare (Walmang No. 8), is a manganese-molybdenum semiautomatic wire composed of a mild steel base tube filled with manganese and molybdenum alloys. It comes in 25-lb coils of 12-in. ID, with a wire diameter of 3/32 in.

Maximum recommended current with this wire is 200 amp, d-c. This produces a deposit having a hardness of RC 13, which will work harden up to RC 51.

Both the electrode and the wire have a low carbon and phosphorous content which provides good impact strength at low temperatures. Also, they both contain alloying elements which make them relatively free from the formation of the carbide precipitate which, in regular manganese steel, produces brittleness upon cooling in the 500 F to 1,600 F temperature range during welding.

Before applying either of the hardfacing alloys, the work surface must be cleaned of oil, grease and foreign material. Any preheating of the base manganese steel must not exceed 500 F.

Electrodes are preferred over oxyacetylene rods because in arc applications, the base manganese steel being repaired is not heated to such an extent as to seriously affect its structure.

The skip welding technique is used so short beads are deposited. They should be peened while still hot and cleaned with a wire brush prior to the second pass.

COATED electrode used for build-up. Electrodes come in metal cans to maintain low-hydrogen content. Picture at top of page shows rebuilding tube wire designed for semiautomatic welder use.

WELDED semitrailer is one application of 5083 aluminum alloy. Carriers are used for storing, transporting and transferring liquid oxygen and nitrogen.

by **R. D. Olleman** and **G. C. Wolfer**
Kaiser Aluminum & Chemical Corp.

Extensive tests show . . .

New aluminum alloy not prone to BRITTLE FRACTURE

ONE OF THE NEWEST and strongest of the aluminum-magnesium-manganese alloys, 5083, offers an extremely desirable combination of properties for cryogenic equipment: excellent weldability and weld ductility; good resistance to corrosion and stress corrosion.

It is currently being used in highly stressed welded structures, and recently has been used in a few cryogenic applications. (See *Mig-welded transports carrying NCG products*, WELDING ENGINEER, Oct., p. 8.)

Field experience in these cryogenic applications is limited, however, and there is some reluctance to using the new alloy in spite of its excellent characteristics. One major reason: fear of brittle fracture at low temperatures.

Many structural alloys suffer a marked loss of ductility at low temperatures, becoming sensitive to stress concentrations caused by accidental notches or necessary changes in part shape. As a result, local failures at a point of stress concentration start easily, and propagate almost instantaneously into complete failures.

However, an extensive battery of tests has shown that at temperatures of —320 F and above, 5083-H113 aluminum alloy plate and welds made with 5183 alloy filler can be used without fear of ductile-brittle transition. And since 5083-0 is a softer,

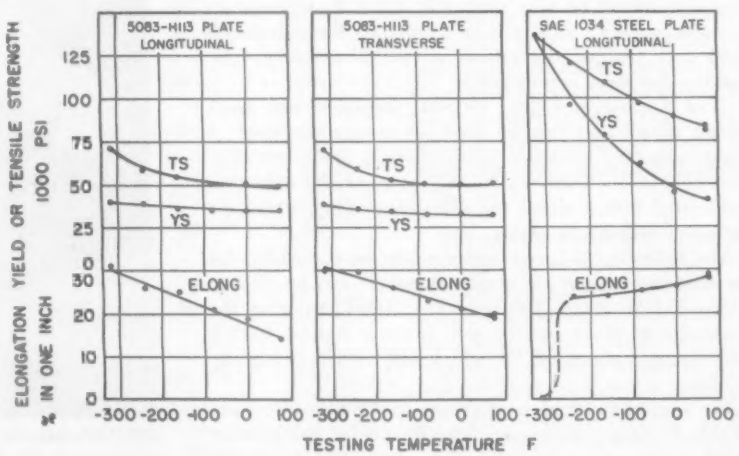

FIG. 1—Low temperature tensile properties of ¾-in. plate of 5083-H113 and 1034 steel.

more ductile-tempered plate, it may also be used at these temperatures without fear of brittle fracture.

Influencing the ductile-brittle behavior of an alloy are two distinct types of factors: metallurgical and service. Typical of the metallurgical factors are temper, microstructure and welds.

In general, the stronger a given alloy's condition, the more susceptible it becomes to brittle behavior, *i.e.*, as strength increases, ductility decreases. There are some exceptions associated with the disruption of embrittling microstructures by compressive plastic deformation, or with their formation by certain elevated temperature tempering or annealing treatments. However, the "harder" tempers of alloys are more prone to brittle failure.

(It is also a common observation that heavy plate of a given alloy and temper is less ductile than lighter plate. This is associated with microstructural changes caused by the larger amount of hot work received by the thinner plate.)

There are three service conditions which can promote brittle fracture in a metal that is ordinarily ductile: low temperatures, high loading rates and stress concentration. In evaluating a metal's ability to resist brittle fractures, therefore, tests are used involving one or more of these three variables. The most severe are those involving all three—impact tests of notched specimens at low temperatures.

Four tests were used to evaluate the resistance of 5083 plate and its welds to brittle fractures: tensile tests, unnotched and notched tensile impact tests, and Charpy keyhole impact tests. In each case, temperatures ranged from 75 to —320 F.

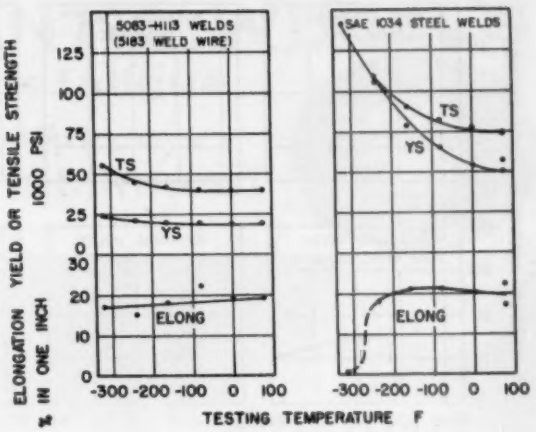

FIG. 2—Transverse tensile properties of ¾-in. plate welds of 5083-H 113 and 1034 steel.

The tensile tests evaluated the effect of only one embrittling service condition, low temperatures, while the unnotched tensile impact tests added a second embrittling condition, high strain rate. The notched tensile impact tests and the Charpy keyhole impact tests provided stress concentration, the third embrittling service condition.

Strain rate in the tensile tests was about 3 x 10^{-1}% per second. In the unnotched tensile impact tests, strain rate at impact was about 10^{4}% per second and much higher in the notched impact tests.

When making the low temperature tests, any desired testing temperature in the range of 75 to —320 F was possible because cooling was done by controlled nitrogen vapor flow rather than by immersion in a cryogenic liquid.

The Charpy specimens were cooled to testing temperature in an insulated box, then transferred with tongs to the impact testing machine in the conventional manner. Tensile impact specimens required development of an entirely new cooling chamber, since they had to be cooled in place, mounted in the pendulum of the machine.

For the study, ¾-in.-thick 5083-H113 plate was used because its temper is much stronger than the annealed 5083-0 which would be at least equivalent to the H113 in brittle fracture resistance.

Plate thickness of ¾ in. was chosen because it is representative of the majority of 5083 heavy plate. Furthermore, it required multi-pass welding, typical of field welding procedures.

Welding was done by the Mig process using 3/32-in. diameter filler wire with argon as the shielding gas. Joint design was a 70 deg included angle, butt-joint with 1/16-in. land and 1/16-in. root opening. Three face passes were deposited and the joint was then back-chipped and completed with one root pass.

All radiographed welds indicated almost complete freedom from porosity or inclusion-causing spots. Areas having imperfections were avoided when specimen blanks were cut.

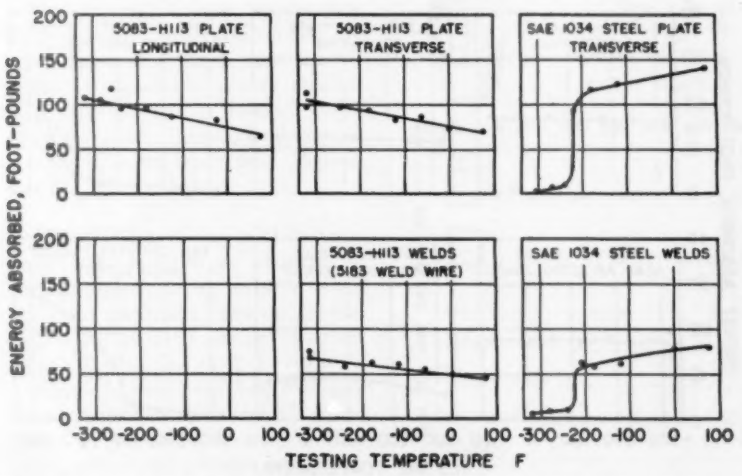

FIG. 3—Unnotched tensile impact tests of ¾-in. plate and welds of 5083-H113 and 1034 steel.

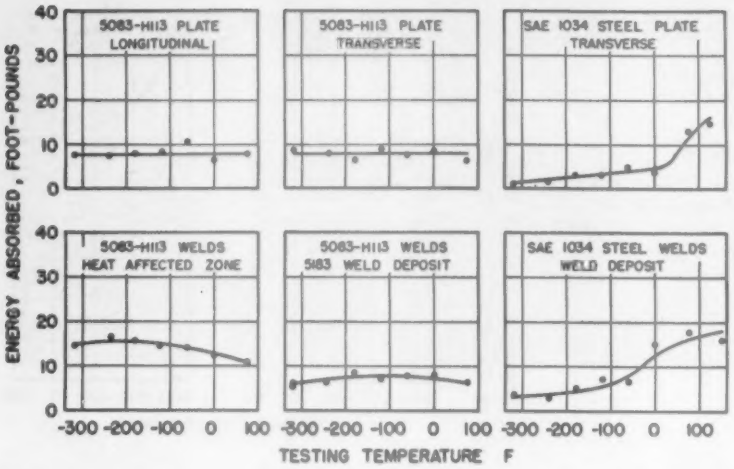

FIG. 4—Notched tensile impact tests of ¾-in. plate and welds of 5083-H113 and 1034 steel.

To demonstrate the effectiveness of the various tests in producing a ductile-brittle transition, tests were also made on plate and welds of a typical ductile-brittle material, plain carbon, SAE 1034 steel.

All four tests were made on the steel plate in both longitudinal and transverse directions, as well as with the specimens transverse to, and centered on, the welds. Notched tensile impact tests and Charpy keyhole impact tests were also made, with notches located in the heat-affected zone next to the welds. Altogether 15 tests were made on each alloy.

Tensile test results are shown in figures 1 and 2. The effect of decreasing temperatures on SAE 1034 steel (figure 1) was typical of its effect on ductile-brittle materials.

Both yield and tensile strength were sensitive to testing temperature changes, and increased as temperature decreased. Yield strength increased more rapidly, however, and as it approached tensile strength, elongation suddenly decreased to almost zero. The ductile-brittle transition occurred between —240 and —320 F.

Yield strength and tensile strength of 5083 also increased with the decreasing temperature. However, the change was relatively small, and tensile strength increased more rapidly. Thus, there was an increasing separation between the two strength properties at low temperatures and increased elongation.

A similar pattern appeared in the tensile tests transverse to the welds (figure 2). In this case, however, elongation of the 5083 plate and 5183 weld deposit decreased slightly as temperature decreased.

This change in behavior, between plate and welds, was associated with *(1)* localized deformation caused by differences in the flow stresses of the plate and the weld deposit, and *(2)* the inherent properties of the cast structure of the weld deposit.

Although elongation of weld specimens did not increase as temperature decreased, the smallest elongation found was greater than the longitudinal elongation of the plate itself at room temperature. There was no ductile-brittle transition in either plate or welds.

Results of the unnotched tensile impact tests are shown in figure 3. The effect of increased strain rate in these tests was to raise the steel's transition temperature zone by 60 F to about —200 or —240 F.

The increased strain rate did not produce a ductile-brittle transition in either the 5083 plate or its welds. In all cases, the energy absorbed by this alloy increased substantially as temperature decreased. The tests also revealed no significant difference between the longitudinal and transverse plate properties.

Energy absorbed by the tests transverse to the welds was lower than for plate tests, largely because of the lower flow stresses and localization of deformation in the weld deposits. The absorbed energy in the weld tests did increase with decreasing temperature at about the same relative rate as the plate tests.

Results of the notched tensile impact tests are shown in figure 4. In these tests all three embrittling service conditions were combined, *i.e.*, low temperatures, high loading rate, stress concentration.

Notch effects with its stress concentration and increased strain rate on the steel plate's transition temperature zone was quite marked, raising it by at least 200 F to above 0 F. Occasional brittle service failures would also be expected with plain carbon steels in lower ambient temperatures. The transition temperature zone of the steel weld deposit was quite broad and extended well below 0 F, indicating it was more resistant

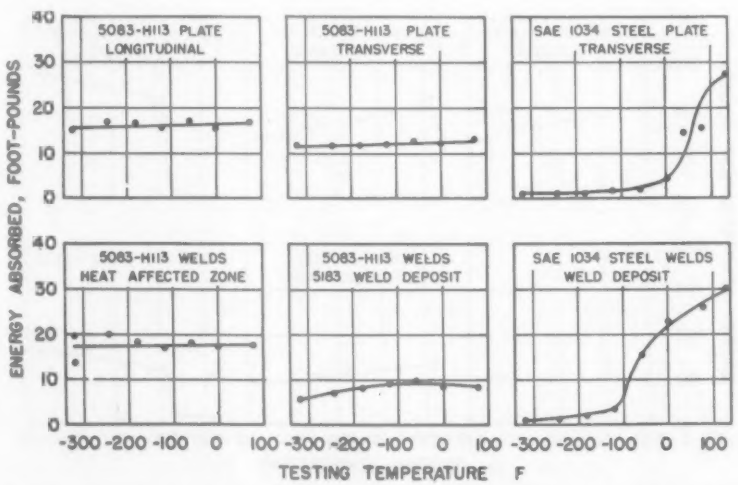

FIG. 5—Charpy keyhole impact tests of ¾-in. plate and welds of 5083-H113 and 1034 steel.

to brittle fracture than the steel plate.

The severe conditions of this test did not produce a ductile-brittle transition in either the 5083 plate or its heat-affected zone, or in the 5183 weld deposit. Plate properties were virtually insensitive to testing temperature.

Energy absorbed with the notch located in the heat-affected zone was higher than for the plate, and increased with decreasing temperature. The lowest average value of energy absorption was found in the weld deposit, but the lowest individual values were equal to the lowest values from the plate tests.

Temperature had a mild effect on energy absorbed by the weld deposit, with a slight maximum apparently occurring between 0 and —200 F. As in previous tests, there was no significant difference in the plate's longitudinal and transverse properties.

Results of the Charpy keyhole impact tests (most likely to produce a ductile-brittle transition in fracture-susceptible material) are shown in figure 5. Transition temperature zones of the steel plate and its weld deposit were about the same as for the notched tensile impact tests. The zones, however, were much more sharply defined.

The severe conditions of this impact test did not produce a ductile-brittle transition in either 5083 plate, its heat-affected zone, or the 5183 weld deposit. Properties of the plate and heat-affected zones were relatively insensitive to temperature changes.

There were, however, appreciable differences in energy absorbed in comparable tests from each set. In order of decreasing energy absorption, they ranked as follows: heat-affected zone, longitudinal plate, transverse plate and weld deposit tests.

The 5183 weld deposit tests were somewhat sensitive to changes in testing temperatures, with a slight apparent maximum between 50 and —150 F. Ratio of energy absorbed at —320 F to that at 75 F was 0.67.

As can be seen from these extensive tests, no ductile-brittle transition was found in 5083-H113 aluminum alloy plate, or in 5183 weld deposits under any of the test conditions at temperatures to —320 F.

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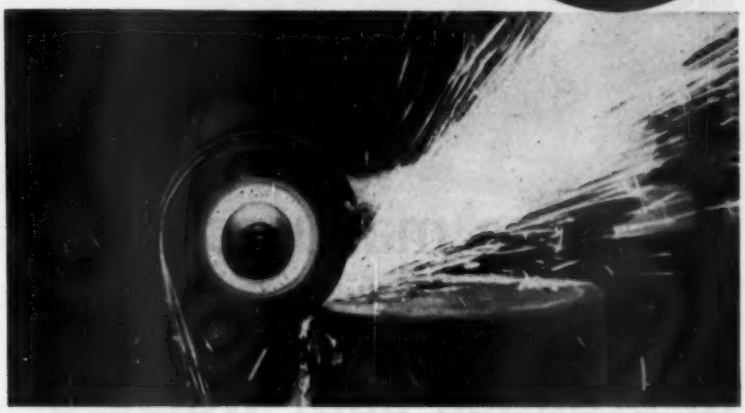

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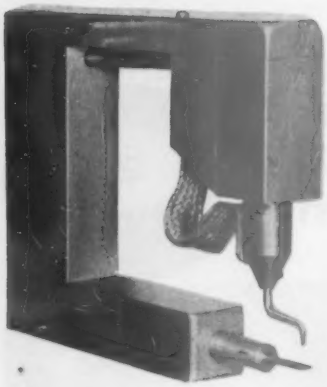

This tube manufacturer's own needs prompted it to produce spot welders

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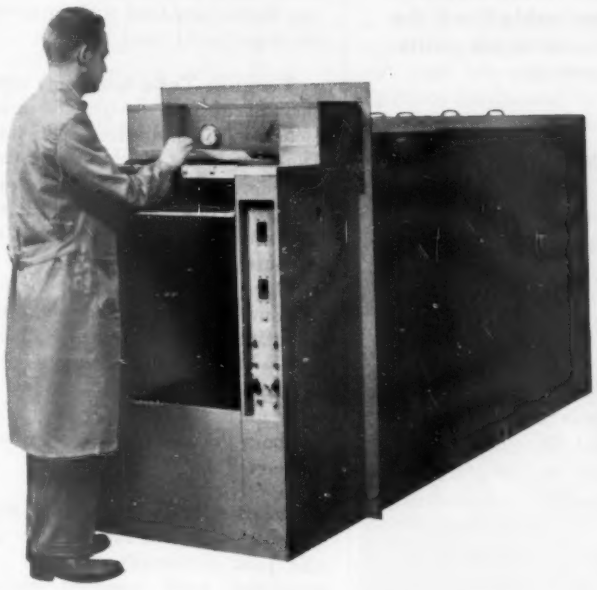

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3 *Fewer Expensive Rejects.* Invincibles remove all fine dust (flux flour), thus reducing welding rejects and speeding production.

Many Important Advantages

- Ruggedly built to resist abrasive nature of flux.
- Compact and lightweight. Variety of models and flexibility eliminate need for tailor-made installations.
- Portable units also available.

WRITE TODAY FOR FOLDER on Invincible Flux Recovery Systems.

INVINCIBLE VACUUM CLEANER MFG. CO.
DOVER, OHIO

by other manufacturers.

Vacuum Tube Products, Oceanside, Calif., manufactures a complete line of electronic tubes. The advanced design and development of these tubes caused the firm to look for a spot welder capable of producing sound welds of the quality needed for such precision items.

The firm decided to find its own answers and its engineering staff developed a light weight weld head which was adapted to work with weld timers then in use.

Next, a vacuum gage tube was designed in which it was necessary to spot weld tungsten wire from 0.0003 to 0.0006-in. in diameter. This operation required a new timing system, and an electronically controlled timer using phase shift heat control was devised and used with the already developed weld head.

Vacuum Tube uses only equipment of its own design and manufacture in the production of its tubes. The units it has developed spot weld 0.010-in. platinum clad molybdenum grids, 0.005-in. tantalum grid bands, 0.002-in. nickel cathodes, and 0.009-in. pure platinum heaters.

When word was out that the firm had developed such equipment, other manufacturers from various industries with similar production operations, asked for equipment to be made for their own application. Thus was born the spot welding division of Vacuum Tube.

Originally, this department functioned as a custom supplier for specific jobs. Eventually, the line was broadened until standard models could be selected to perform the majority of customer requirements. All machines were made to stay within the portable class.

The firm now manufactures and sells other welders and timers, variable from 0 to ½ cycle, ½ to 10 cycles and 2 to 20 cycles. Also produced are various welding accessories and weld heads, including a Tig welder being used in missile fabrication to produce gas-tight stainless steel foil assemblies.

One service of the company helps customers select the correct unit and methods for meeting their particular requirements. Samples are received daily and processed by an experienced engineering staff.

HERE'S THE FIRST SEMI-AUTOMATIC OPEN ARC WIRE FOR HIGH STRENGTH WELDS ON MANGANESE STEEL

WEAR-O-MATIC WH

Wear-O-Matic WH is the first 7/64" diameter open arc wire for semi-automatic application providing acceptable high strength properties for welding manganese attachments to manganese or carbon steels.

Here's a new wire providing welds of greater strength and ductility than 14% manganese weld metal that can be applied by the easier, more economical Wear-O-Matic open arc semi-automatic process. The balanced, high alloy content of the fabricated wire is sufficient to overcome the effects of dilution with manganese or carbon steel resulting in a weld deposit in the fully austenitic range. This, of course, provides a tougher, more crack resistant weld deposit.

Wear-O-Matic WH serves a dual role in that the exceptional physical properties that provide strong ductile welds also provide a tough, deformation resistant mass when used as a build-up alloy. The deposit develops a surface hardness of 47–48 Rc under impact providing exceptionally good wear resistance.

NEW NEW NEW NEW NEW

- **For impact and compression resistant attachment welds . . . specify WEAR-O-MATIC WH**
- **For tough, dependable build-up deposits . . . specify WEAR-O-MATIC WH**
- **For greater economy in all of your hard surfacing and maintenance welding, call on your Alloy Rods factory branch or distributor.**
- **Write for Bulletin HS202 for details and locations. Alloy Rods Company, P. O. Box 1828, York, Penna.**

NEW NEW NEW NEW

Alloy Rods Company

YORK, PENNSYLVANIA • EL SEGUNDO, CALIFORNIA

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350 FACTORY TRAINED TECHNICAL REPRESENTATIVES ARE AT YOUR DISPOSAL FOR CONSULTATION AND PRACTICAL ASSISTANCE WITH YOUR WELDING PROBLEMS.

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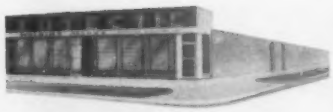

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To provide prompt, on-the-job service to its thousands of customers all over the United States and Canada, EUTECTIC maintains an extensive network of Service Center Warehouses. EUTECTIC spans the world and operates manufacturing plants through affiliated companies in Canada, Mexico, Brazil, Switzerland, England, Germany, France, South Africa.

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FOR 20 YEARS IN THE WELDING INDUSTRY

SURFACE-to-surface Atlas missile is fired at Patrick Air Force Base, Florida.

by C. F. Crowson
and A. H. Butler, Jr.*

Missile age rockets ahead as army enlists welding

PROBABLY THE MOST CRITICAL part of any missile is its rocket engine, since success or failure hinges initially upon the power plant.

One of the most successful United States missiles is the Army's Redstone, currently operational and deployed in both the U.S. and Europe. And it was a modified Redstone, the Jupiter-C, that carried aloft America's first earth satellite, Explorer I. The Redstone engine was developed and is being produced by Rocketdyne, Div. of North American Aviation Corp., Canoga Park, Calif.

In 1946, North American proposed a surface-to-surface guided missile with an engine similar to Germany's V-2. In 1947 the U. S. Army turned over a captured V-2 engine to the company with a request to improve its design and production methods.

A completely new engine evolved and was tested in 1950. Two years later the production engine went into service. It developed a 75,000-lb. thrust, compared to the 56,000-lb thrust of the V-2. Design improvements, manufacturing efficiencies, and a great reduction in the number of components needed resulted in the engine with the highest reliability—99%—of any engine yet in production.

Weld strength and quality has played an important part in this high reliability. For example, the aluminum outer wall of the engine's heat exchanger and the finishing welds on the engine's critical thrust chamber are manually Tig welded, and the engine's peroxide tank, constructed of 17-7 ph stainless steel, is joined by a Tig torch mounted on a special carriage.

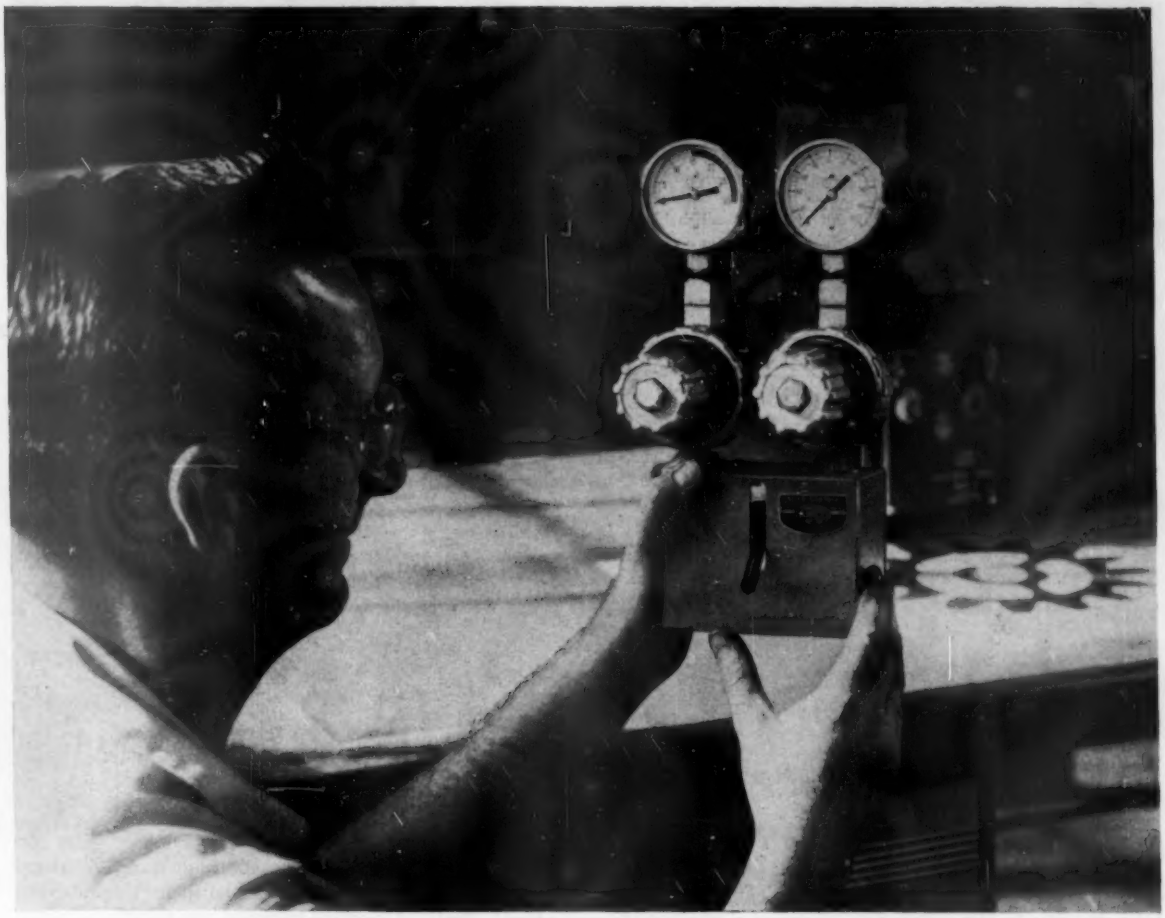
Versatility was the main reason Tig welding was chosen to join components of the Redstone engine. It can be used on many different metals and thicknesses, delivering the same quality on each.

All Tig welds undergo strict X-ray inspection before the engine is assembled on a static test stand. After final factory approval, the engine is ready for shipment to Chrysler Corp. in Detroit. (See "Army's Redstone and Jupiter missiles are on target," *WE*, April, p. 42.)

More than 1,000 ft of welds go into the construction of the aluminum casing used for the Jupiter-C rocket and the Redstone ballistic missile. The casings are fabricated at the Reynolds Metals Co. missile plant at Sheffield, Alabama. Performance records show that because of precision welding, constant research and intensive inspection, no Redstone or Jupiter-C has ever failed due to faulty welds.

To insure quality, the plant employs an inspector for every four technicians who work on the casings. The aluminum sheet and incoming parts are checked for blemishes and tested with electronic devices to detect potential weak spots which might fail in flight. Samples of each lot are withdrawn for chemical analysis and a complete record is made of every part selected to go into the missile. The sheet is then covered with protective paper tape to reduce the chance of being scratched during fabrication.

*Mr. Crowson is manager, electric welding, Linde Co., Birmingham, Ala., while Mr. Butler is a welding sales engineer, Linde Co., Los Angeles, Calif.



AIRCO'S NEW HI-LO CONTROL FOR MACHINE TORCHES

gives you substantial gas savings

IT SAVES GAS BECAUSE YOU CAN GET

- *proper preheat flow for starting a cut*
- *minimum flow for balance of cut*

The Duplex HI-LO Control enables the flame cutting machine operator to vary preheat oxygen and fuel gas during the cutting operation . . . from a heavy preheat at the start to a lighter preheat once the cut is underway. Less oxygen and fuel gas are consumed.

Additional bonuses are faster starts and quality cuts free from melted-down edges and warpage.

The Duplex HI-LO is simple to operate, and moderate in cost. A Single HI-LO is also available for adjusting preheat oxygen only when low pressure fuel gas is used with injector-type torches. Both can be used with all Airco flame cutting machines.

For more information, call your nearest Airco district office or authorized Airco dealer. They are listed in the Yellow Pages under "Welding Equipment and Supplies."

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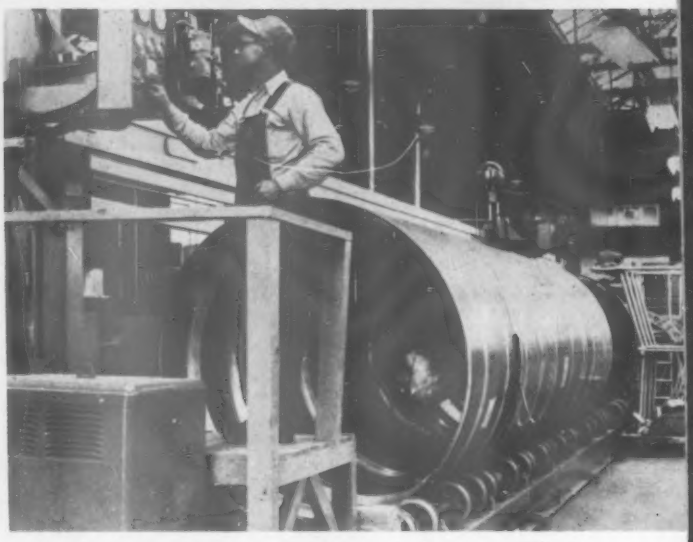
FOUR of various welding operations needed in completing Redstone missile are shown in these pictures. At left, Tig welding of outer wall of aluminum heat exchanger for engine; at right, Tig welding exterior of double-walled thrust chamber; lower left, Mig welding longitudinal center section; lower right, circumferential Mig weld on fuel tank.



Each 20-ft sheet of type 5086 alloy is trimmed to size to form a shell meeting a 0.015-in. OD tolerance. After the sheets are rolled into a cylinder, the edges are cleaned, scraped and automatically Tig welded at speeds up to 100 ipm. The shell is then trimmed in length to a 0.020-in. tolerance and aluminum "Z" rings are spot-welded inside to support the shell.

Eight shells of varying lengths are joined to form the center section, or fuel tank, of the Redstone. These shells contain the bulkheads of the tank. The shells are assembled on another automatic Mig machine and girth welded at speeds up to 55 ipm.

Power settings are usually 160-250 amp, 20-22 volts. Average welding time is only 4 to 10 minutes, but preparation takes the major part of time due to the extreme care required. First, the weld area is scrubbed with trichlorethylene, then the edges of the sheet are scraped with a special power scraper to remove oxide. Several power interlocks are provided to prevent machines with heavy electrical-current drains from starting during the critical weld cycle.

Prior to welding, a sample weld is X-rayed and checked for physical properties. After welding, each weld is X-rayed to double check weld quality. When the center section meets radiographic and dimensional inspection, a series of aluminum pipes—which carry liquid oxygen, alcohol or other fuel—are welded in place. The completed section is then ready for hydrostatic test, calibration, chemical cleaning, final assembly and finishing.

When the center and tail sections get final approval, the casing is forwarded to the Chrysler plant where the engine and instrumentation-systems are added to the ballistic shell to form a complete Jupiter-C or Redstone missile.

U.S. missiles and their status

MISSION	OPERATIONAL	IN PRODUCTION IN 1959	FINAL RESEARCH & DEVELOPMENT
Surface to surface	Honest John Corporal Redstone Regulus I Matador Thor	Little John Lacrosse Mace Jupiter Snark Atlas	Sergeant Pershing Polaris Titan Minuteman
Surface to air	Nike Ajax Nike Hercules Terrier Talos	Hawk Bomarc	Tartar Nike Zeus
Air to surface	Bullpup	Zuni	Corvus Hound Dog Quail
Air to air	Genie Sidewinder Sparrow I Sparrow III Falcon Gar I Falcon Gar II	Falcon Gar III Falcon Gar IV	Falcon Gar IX Falcon Gar XI Eagle

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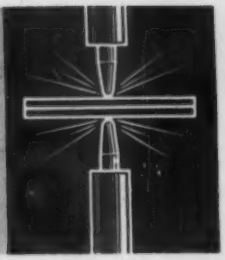
MALLORY MEMOS

NEWS AND TIPS ON RESISTANCE WELDING

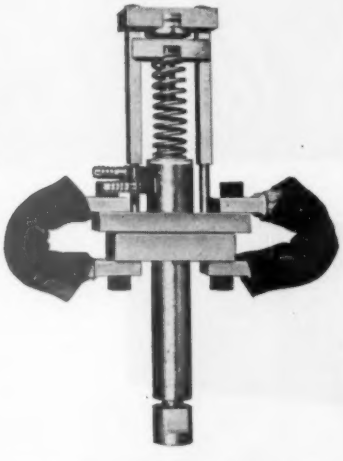
P. R. Mallory & Co. Inc., Indianapolis 6, Indiana



WELDING HINTS

Do you have the Mallory Resistance Welding Data Book?

It's one of the most complete reference books ever written on resistance welding. Over 500 pages of up-to-date metallurgical information and practical facts for designers and production men. Edited by Mallory welding specialists. You'll find it on the desks of leading welding men everywhere. The latest edition, in durable hard cover binding, is available from your Mallory distributor.



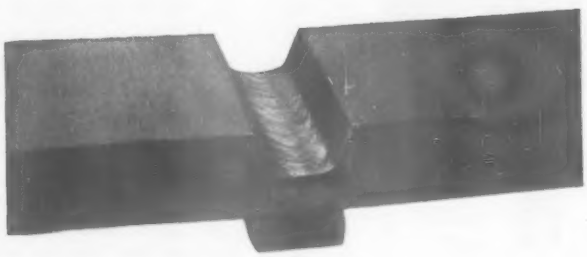
For welding "difficult" metals such as light gage brass and aluminum which have limited plastic range, use the new Mallory precision low-inertia holder. Wide range of pressures available with easily interchangeable springs. Ask your Mallory distributor.

Get More Welds Per Dollar with Cool-Running MALLORY Fluted Electrodes

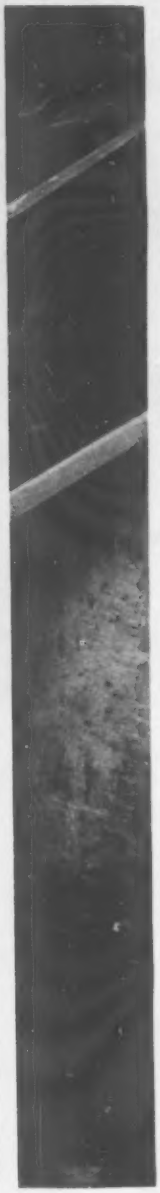
How many welds can you get from an electrode? Part of the answer is determined by how cool the electrode runs. Excessive heat softens the metal, causes "mushrooming," wastes production time by requiring shutdowns for dressing tips. Mallory fluted electrodes have 70% more metal-to-water area inside them than round-hole types. Because they run far cooler, they make *more* welds before need for dressing. And they make *better* welds . . . because they don't flatten out and give you inadequate concentration of heating that can cause weak welds.

The exclusive Mallory fluted hole is available *without extra cost* in many types of Mallory straight, single and double-bend electrodes. It's one of the important extra values you get from Mallory—leader in resistance welding supplies for over 30 years.

A Mallory distributor near you carries a broad line of standard Mallory electrodes. He can give you immediate delivery of any of 200 different shapes and sizes. Before you go the cost of "special" electrodes, let him show you how a Mallory standard design can do the job for you without special cost.



Smooth bead and good wash-in,
give Jetweld 2 easy slag removal.



Did you ever think
that you would find

an E6027 for the same price as an E6020?

Jetweld 2 *is* that rod!

Designed specially for
welding grooves and flat fillets,
Jetweld 2 has qualities
that production men gloat over.

It makes such smooth beads
that there is no need
to grind off cover passes,
even for taking X-rays.

It restrikes cold.

The exceptional wash-in
and easy slag removal
cut cleaning time to virtually nothing.

The deposit speed and
quality is unsurpassed, reducing
welding costs to rock bottom.

And it sells at
the same price as E6020 rods.

No wonder, more and more
profit-conscious companies
are switching to Jetweld 2.

It is the best E6027 on the market!

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The world's leading manufacturer of arc welders, electrodes, ac motors and battery chargers

P. S. Don't forget Jetweld 2's
high strength, brother—
Jetweld 2-HT.

All the same advantages, plus
70-80,000 tensile strength
and 25-30% elongation . . .
now available in $\frac{3}{16}$", $\frac{7}{32}$" and $\frac{1}{4}$" sizes.

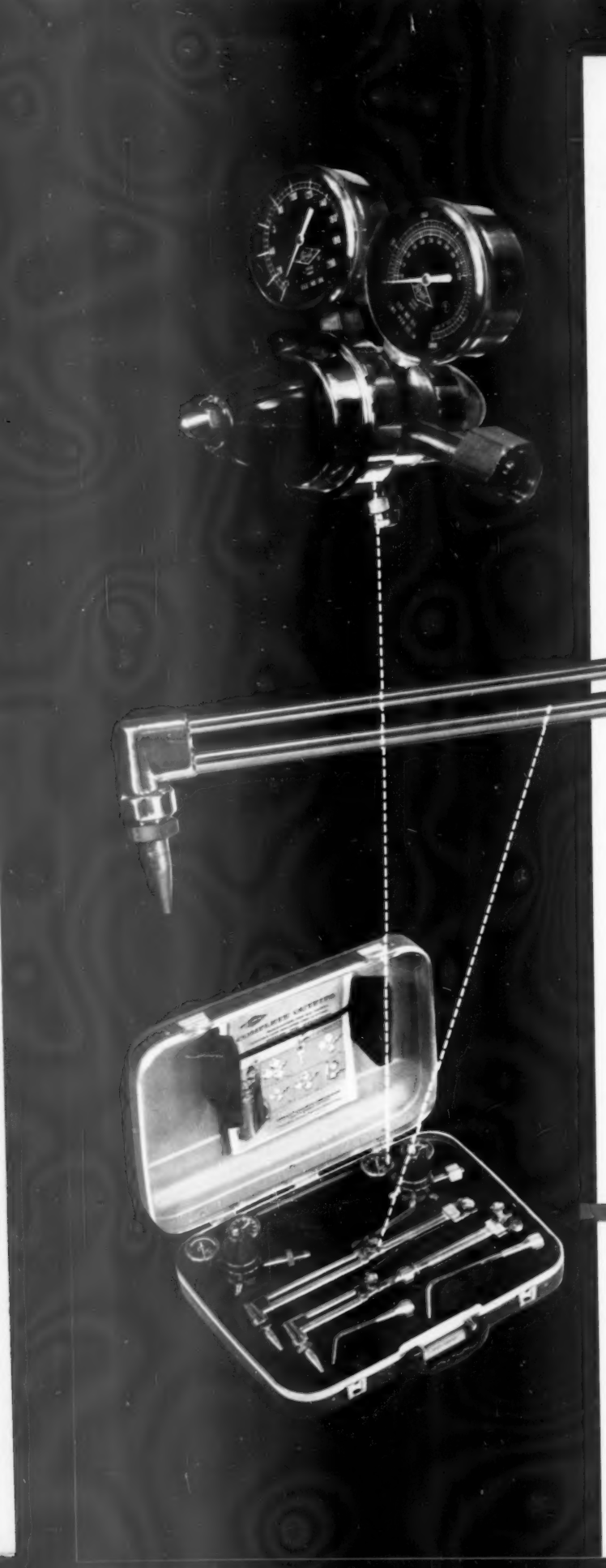
WELDOR completes stainless steel firewall attaching ring for pod of DC-8 commercial transport plane designed by Douglas Aircraft Co. Ryan Aeronautical Co., San Diego, builds pods and pylons for DC-8, using titanium, aluminum and stainless steel.

ENGINEER from The Budd Co., Philadelphia, is making strain tests on model of stainless steel fuel container for rockets. PhotoStress birefrigent plastic and MetalFilm strain gages, produced by Tatnall Measuring Systems Co., Budd subsidiary, are being used to stress analyze pressure vessel. Stainless steel AM-355 is made by Allegheny Ludlum Steel Corp., Pittsburgh. It is a new type precipitation hardening metal especially for use in super-speed aircraft and missile parts which give high strength-to-weight ratio to fuel casings.

On the job...

ALUMINUM containers for airshipment, handling and storage of U. S. Air Force's Falcon air-to-air missiles are produced by Allison Steel Co., Phoenix, Ariz. Below, clamping jigs are used to hold ends of container for tacking to longitudinal sections prior to welding. Airtight joints are produced by Tig process using 5154 aluminum electrodes. Containers are made of 5086 aluminum alloy, supplied by Kaiser Aluminum & Chemical Corp., Oakland, Calif. Units are constructed to protect missile and must withstand free falls of 16 ft without rupture. They are 8 ft long, 21 in. wide and deep, and weigh 133 lb, empty.

APPROXIMATELY 13,000 studs, 5/16-in. in diameter and 1¼-in. long, helped save 30% in labor costs during installation of insulated aluminum curtain wall for Fuller Brush Co. warehouse. Galvanized tee bars, 16-ft long, span three girts. Bars, 1-in. thick insulating sheets and 0.032-in. thick aluminum sheets were impaled over studs. Nelson Stud Welding Div., Lorain, Ohio, supplied studs and welding equipment.



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- ***Finger-tip control is provided by easy-grip adjusting cap and self-lubricating, nylon-pointed adjusting screw.***
- ***Freezing, vibration and seat ignition are eliminated—even when subjected to full cylinder pressure—by exclusive stabilized seats.***

Liquidweld Torches

- ***Longer life, better flame control and uninterrupted performance are assured by nylon-tipped needle valve stems.***
- ***Designed with the precison of a timepiece, these all-purpose torches cut, weld, braze, and heat all metals, from the lightest to the heaviest.***

For these and many more production-boosting advantages, call your Liquid Carbonic representative—ask to see his "Case of Jewels" today!

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Liquid Carbonic Division
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I would like to know more about Liquidweld apparatus.

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( ) Please send literature and net industrial prices.

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Company.....

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Single circumferential butt-welds

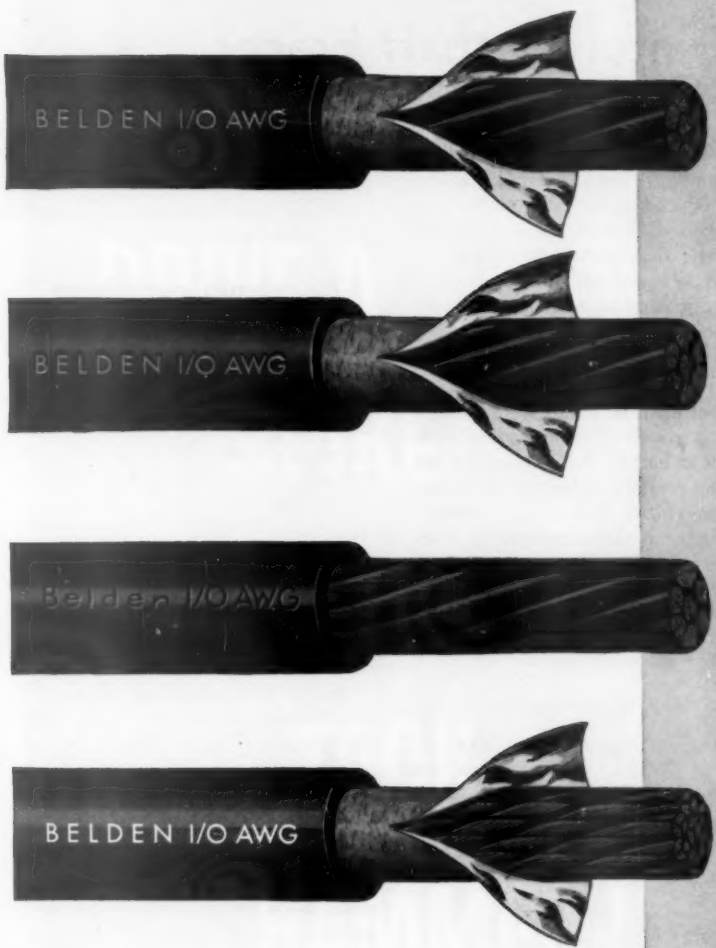
(for fabricating critical piping in nuclear applications)

CLASSES OF QUALITY			I		II		III		IV	
			IA	IB	IIA	IIB	IIIA	IIIB	IVA	IVB
BRIEF DESCRIPTION OF BASIC DIFFERENCES			Static and Fatigue Strength equals Unwelded Pipe		Static—but not Fatigue Str'gth equals Unwelded Pipe		Average Static Strength equals Unwelded Pipe; Fatigue Strength appreciably below Unwelded Pipe			
			O.D. Surface fully smooth		O.D. Surface reasonably smooth		O.D. Surface as welded			
			NO Backing Ring		NO Backing Ring	Drive-Fit Backing Ring	NO Backing Ring	Drive-Fit Backing Ring	NO Backing Ring	Snap-Fit Backing Ring
			I.D. machined or sized		Mill End Pipe	I.D. machined	Mill End Pipe	I.D. machined	Mill End Pipe	
			I.D. Surface smooth	I.D. Surface slightly irregular	I.D. Surface as welded, Root Offset permitted		I.D. Surface as welded, Root Defects present			
			Fully examined by all Practicable Methods		Fully examined by Radiographing and Intrascope		Spot examined by Radiographing and Intrascope		Outside Visual Examination only	
PERMISSIBLE PROCESS FOR ROOT PASS			Inert Gas Metal Arc with Inert Gas Shield on I.D.		Acceptable Process capable of achieving Required Quality					
JOINT PREPARATION	Backing Ring	Machined Drive-Fit	NOT permitted unless of Consumable Type		Not used	Acceptable except for Austenitic Steels	Not used	Acceptable	Not used	Acceptable
		Commercial Snap-Fit				NOT permitted		NOT permitted		
	End Preparation	Inside Diameter	Machined to Close Tolerance ❶		As supplied; Locally ground for Fit-Up if necessary	Machined on Taper for Backing Ring	As supplied	Machined for Backing Ring	As supplied by Mill	
		Weld-Lip Thickness	1/32", Close Tolerance		1/16" Nominal		1/16" Nominal		1/16" Nominal	
		Weld Groove	Machine Tool Cut		Machine Tool or Machine Flame Cut				Tool or Flame Cut	
		Weld Groove Contour	U-Bevel		t ∠ 3/8": 30°-37½° V-Bevel t > 3/8": U-Bevel				30°-37½° V-Bevel	
	Fit-Up	I.D.	Subject to Close Tolerance		1/16" max Offset	Drive Fit	Mill Pipe Tolerance	Drive Fit	Mill Pipe Tolerance	
		Root Gap			±1/32"		±1/32"		±1/16"	
WELD SURFACE	O.D.	Overlay and Finish	Smooth inert Gas Deposit, or Arc Deposit, ground smooth. 1/16" max Reinf.; NO Undercuts, Scratches or Shoulders		Per ASME Code, Sect. VIII, Par. UW51, except Undercutting permitted per ASA B31.1; Par. 630		Finish per ASA B31.1 Code, Par. 630 (a) (6)		Finish per ASA B31.1 Code, Par. 630(a) (6), except 3/64" Undercutting permitted	
	Inside Diameter	Oxidation	NO Oxide Inclusions		—		—		—	
		Protrusion	1/16" max	1/32" av'g 1/16" max	1/8" av'g	—	Per ASA B31.8 Code, Par. 829 ❷	—	As results from Acceptable Procedure and Tolerances	—
		Smoothness	Substantially Smooth, and blending smoothly into Pipe Wall. NO Undercuts	Same as IA, except Occasional Minor Ripples acceptable	As results from Approved Procedure and Fit-Up Tolerances					
	Penetration		Complete		Complete to the I.D. of the Pipe having the Greater I.D. of the 2 Pieces being joined		Nominally same as Class II, except for Limited Lack of Penetration (ASA B31.8, Par. 829)			
NON-DESTRUCTIVE EXAMINATION	Visual		Required at Fit-Up, during Welding, and for Outside Surface of Each Weld		Required for Fit-Up and Root Pass of Each Weld and for Outside Surface of Each Weld		Req'd for Outside Surface of Each Weld; Spot Checking of Fit-Up and Welding required		Required for Outside Surface of Each Weld	
	Intrascope or equal Examination of Root		Required for Each Weld		Req'd for Each Weld	Not Applicable	Spot Check 1 Weld in 20 of Each Welder	Not Applicable	NOT required	
	Radiographic	Extent	Complete		Complete		2% of lineal ft of Welding (50 ft Units)		NOT required	
		Sequence	After Post Heat Treatment		After Post Heat Treatment for Air Hardening and Austenitic Steels		—			
		Interpretation	ASME Code, Sect. VIII, Par. UW-51		ASME Code, Sect. VIII, Par. UW-51, except outer Surface Undercutting acceptable and Root Penetration and Protrusion to be judged by Intrascope	ASME Code, Sect. VIII, Par. UW-51, except Outer Surface Undercutting acceptable	ASA Code B31.8, Par. 829, except outer Surface Undercutting per ASA Code B31.1, Par. 630 (a) (6); Root Defects to be judged by Intrascope ❷			
	Retest if Spot Examination Unsatisfactory		—		—		Examine Root of 2 more Welds and 4% additional lineal ft of Welding; If unsatisfactory, Rest of 50 ft Unit must be examined		—	
	Ultrasonic		Required		Desirable		NOT required		NOT required	
	Magnetic Particle		Required for Magnetic Materials		Required for Ferritic Materials over 2% Cr					
	Penetrant Oil		Required for Non-Magnetic Materials		Required for Austenitic Materials					

(1) ID machining to provide ½-in. minimum radius and 1:4 minimum taper at runout and 40 micro-inch finish.
(2) The B31.8 Code Par. 829 permissible defect lengths are suitable for large pipe, but require adjustment for application to small diameter pipe.

Courtesy Tube Turns Div., Chemetron Corp.

Belden Welding Cable
the Complete Line



O.T.R. Rubber-Jacketed Cables
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Resist oil, grease, heat, sunlight, mechanical abuse, and ozone set up by high frequency welding or atmospheric conditions.

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High voltage-frequency vinyl insulation affords perfect resistance to corona and ozone cracking . . makes this cable ideal for high frequency welding. High resistance to abrasion, oil, and impact.

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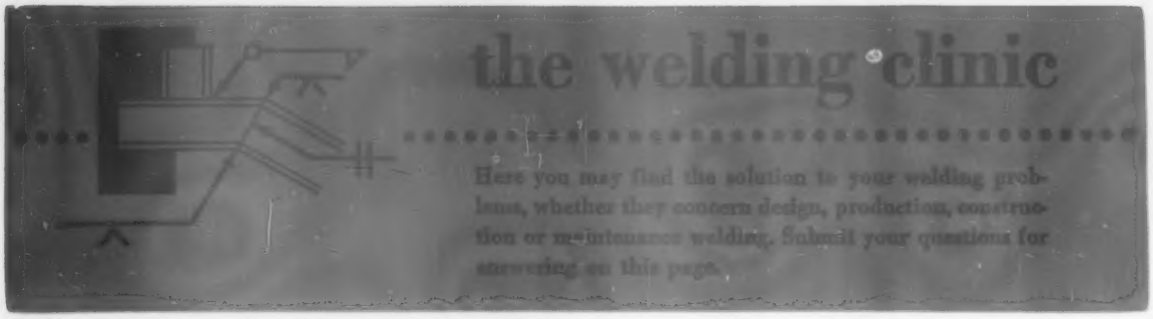

the welding clinic
Here you may find the solution to your welding problems, whether they concern design, production, construction or maintenance welding. Submit your questions for answering on this page.

Remote removal of internal shaft braces

Question:

Can you outline any procedure for cutting and removing braces from inside vertical shafts which do not provide enough working room for a cutter to enter the work area?

Answer:

While working as a burner in a shipyard during the war, Don Jones of Torrance, Calif., devised a method of removing bracing from inside ships' funnels after they had been placed in position.

First, stand directly above one end of the brace to be cut. Light and set your torch at a neutral flame and tie or wire the trigger in place so the flame will burn continuously.

Then, lower the burning torch by its hoses to the upper edge of the brace, holding it there until it starts to cut. After cutting starts, lower the torch carefully as it slices through the brace.

If braces are not to be dropped to the bottom of the shaft, maneuver the torch until a slot large enough for a slipline to pass through is made. Next, lower a loop through the slot, tighten it around the brace and cut the other end. The brace should then be hanging by the dropline ready for removal.

If the bracing is of pipe, round-edged, heavily painted or rusted steel, a pre-heating torch must be used in conjunction with the cutting torch.

* * *

The following are some suggestions offered by Mr. Jones to cutters to help them in their work.

Lighting the torch

Open both valves before you light a cutting or welding torch, closing the acetylene valve first when turning the torch off. The man who lights the acetylene first, dirties his torch tip, contributes soot and black smoke to the air he breaths, and marks himself an amateur, says Jones.

Scale removal

When a cut in a mill scale covered plate is required to be quite accurate, it is helpful to first remove the scale by roughly laying out the work, then moving a hot (high volume) neutral flame along the line or lines to be cut. This will remove much of the scale. After this heat treatment, you can scrape off the loosened scale, lay down a set of good lines, and make an accurate cut.

Washing welds

In the washing or cutting away of welds a 45 deg. flat tip should be used with about 12 to 14 psi of acetylene and just enough oxygen pressure to maintain a neutral flame.

Use of too much oxygen pressure will result in digs into the parent metal. Six or eight feet of light lead hose is helpful, especially when a burner or weldor has much vertical or overhead work to do.

Petroleum containers

Mr. Jones offers a word of warning, "Never use any kind of flame on a gasoline or oil tank or drum until it has been thoroughly steamed out." A barrel may lay in a field for eight or ten years but still have enough residue of oil in it to explode when heated.

Thin metal

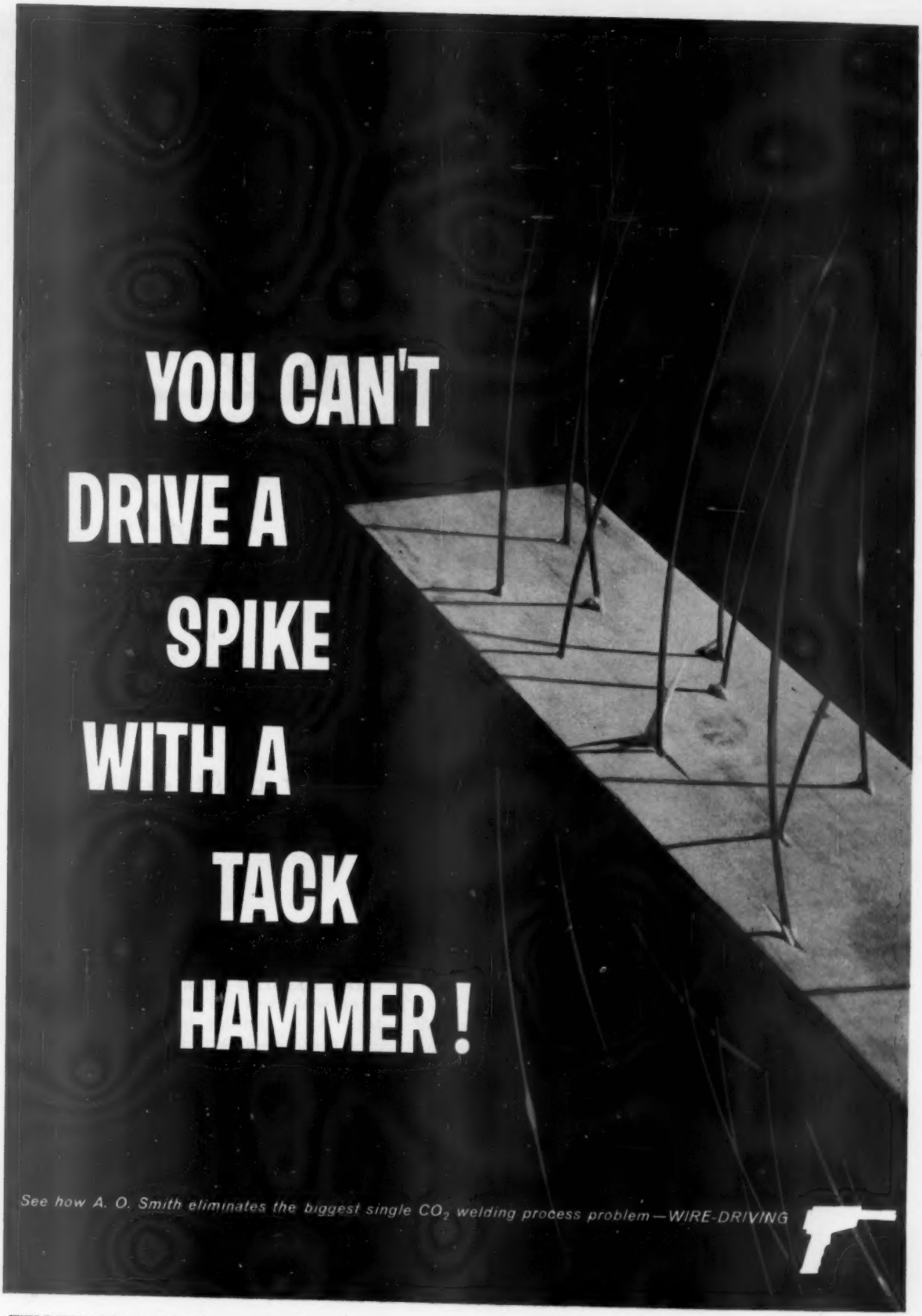
To cut very thin sheet metal, hold the torch so that the tip is at a very small angle-to-work, about 10 to 12 deg. Move the torch along the line of the cut as rapidly as possible without interrupting the cut. Use a small tip and very small flame. Careful marking and a few dry passes along the line will help.

Piercing plates

When piercing heavy plates or rivets use a general purpose tip, and 40 to 45 psi of oxygen. Preheat the work and, to avoid a bath of molten steel, press the trigger smoothly—don't jerk it.

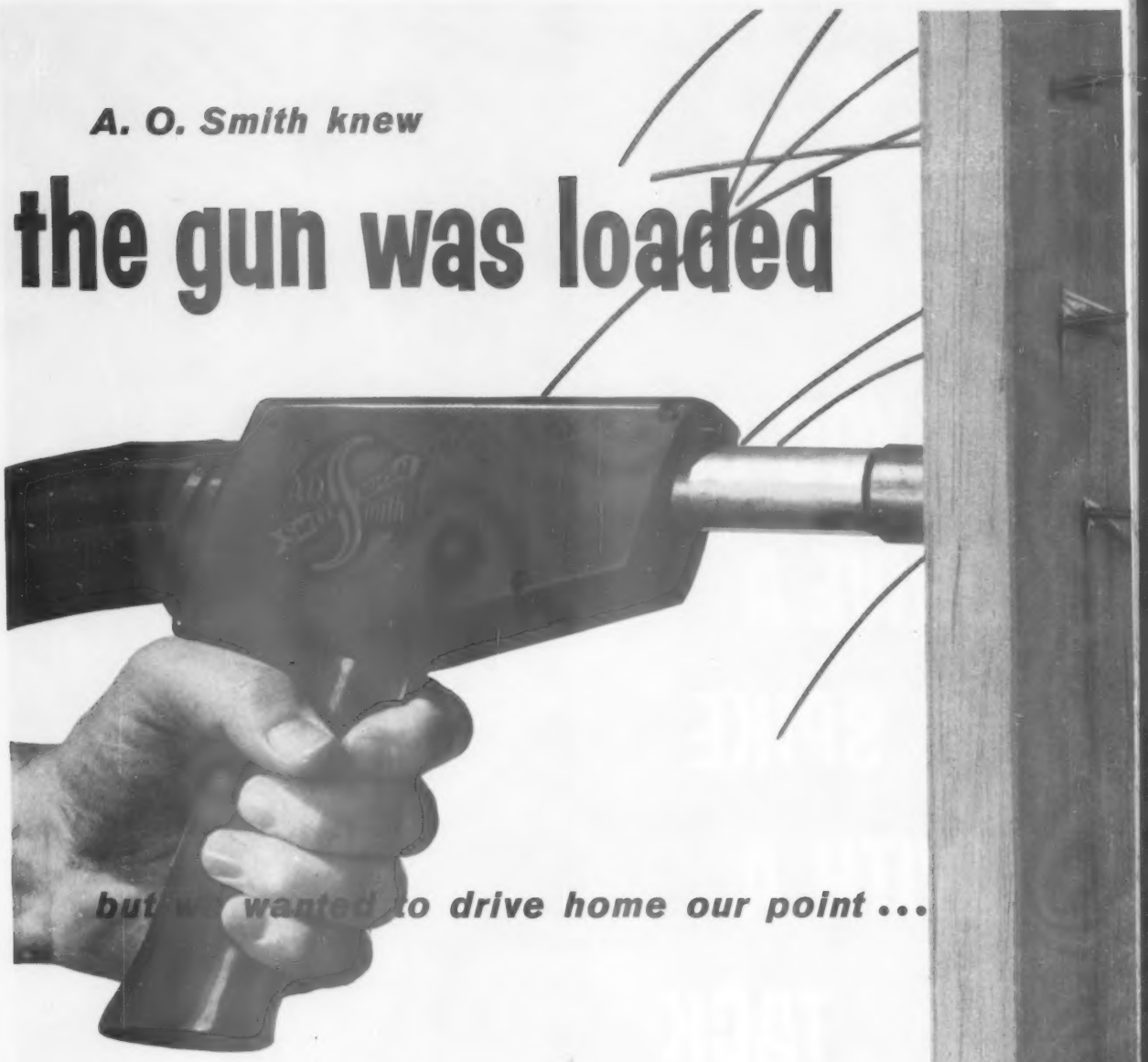
Glove lubrication

Restrictions in working space sometimes make it necessary to drag the torch instead of using the right to left side-swing method of cutting. A little soapstone applied to your glove or any other surface you drag your torch over will act as a lubricant and make the going easier.


YOU CAN'T
DRIVE A
SPIKE
WITH A
TACK
HAMMER !
See how A. O. Smith eliminates the biggest single CO_2 welding process problem—WIRE-DRIVING

A. O. Smith knew

the gun was loaded



but we wanted to drive home our point . . .

that A. O. Smith automatic and semi-automatic welding equipment has more wire-driving "beef" than any other system in the field.

We drew a bead on a slab of wood with an A. O. Smith C-OMANUAL hand gun. The results were amazing — even to us. As you can see in the photograph, standard 1/16" diameter welding wire smashed completely through.

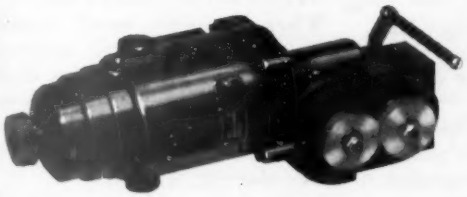
The same test was tried using the C-OMATIC unit with even more penetrating results. A. O. Smith's tested combination of control and wire-feeding system coupled with bonus horsepower drove the wire through an even thicker piece of wood. Positive proof of performance.

Try this convincing test at the National Metal Show — Booth No. 1446.

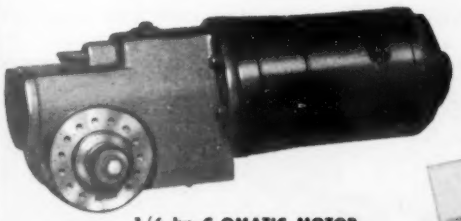
MADE BY WELDERS FOR WELDERS . . .

What does this test mean to you?

Just this! The same explosive power gets welding wire smoothly through the automatic head or hand gun. Let's face it. It is the inability of most CO_2 equipment to keep wire feeding continuously without lags and slowdowns that is causing the most trouble along production lines. A. O. Smith has met the problem with more *horsepower* — the biggest, huskiest, most powerful motor on *any* automatic or semi-automatic welding equipment.



1/5 hp C-OMANUAL MOTOR



1/6 hp C-OMATIC MOTOR

MORE POWER — C-OMANUAL's big, rugged motor develops 1/5 hp as compared to only 1/12 and 1/10 hp on competitive semi-automatic equipment. Exclusive features include thermal overload protection and special oversized brushes. C-OMATIC's head and drive rolls deliver motor's full 1/6 hp with an exclusive 2-speed shift lever gear box providing low speed, high torque advantage.

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A. O. Smith has licked the small problems too!

MAINTENANCE PROBLEMS
Speed control on C-OMANUAL is mechanical. Can be serviced by your regular shop electricians.

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A. O. Smith's cooler-operating, water-cooled hand gun drastically reduces spatter pickup and has no "O" rings. Water leakage has been completely eliminated.

ARC CONTROL PROBLEMS
Modern applications of the automatic or semi-automatic process require a range from over 40 to less than 20 volts. Only A. O. Smith gives such wide range plus the arc control features shown below.

- **Widest voltage range** available on any automatic or semi-automatic welding equipment — *0 to 45.4 volts.*
- **Stellarweld** direct-current reactor materially reduces weld spatter, especially at lower currents, makes CO_2 process practical with light-gauge material.
- **Slope control** permits any variation of volt-ampere curve from very flat to very drooping.

CRATER FILL PROBLEMS
Variable crater fill adjustments on C-OMATIC control panel are micrometer dial type — five times the range of any competitive pointer dial type.

For the complete story on A. O. Smith automatic and semi-automatic CO_2-shielded welding processes, write for informative booklet, "Who's Who in CO_2."

Through research A.O. Smith *... a better way*

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WELDING PRODUCTS DIVISION
Milwaukee 1, Wisconsin
A. O. Smith INTERNATIONAL S. A., Milwaukee 1, Wisconsin, U.S.A.

by **John Delmonte,** *General Manager, Furane Plastics, Inc., Los Angeles*

Plastic welding fixtures add light-weight preciseness to manufacturing operations

DEVELOPMENT OF STABLE, high temperature epoxy laminating resins was the first step towards providing the welding industry with a new, economical method of producing holding and assembling fixtures.

When combined with glass cloth, the epoxy resins can be laid into complicated contours, at little expense, and serve as welding fixtures. These procedures are being quickly adopted not only by the sheet metal shops of aircraft, missile and automotive manufacturers, but also in the heavy machinery and shipbuilding industries.

Producing laminated epoxy welding fixtures is an art which can be readily learned by welding shop personnel.

First, a model must be prepared, or parts to be welded precisely assembled. These parts are coated with release agents to permit the epoxy plastic to be removed.

Because most weldments involve spatial relationships, the most economic use of epoxy plastics involves laminated structures. Gel coatings may be first brushed over the surfaces of the models or assemblies at those areas where the fixture is to be fitted or attached.

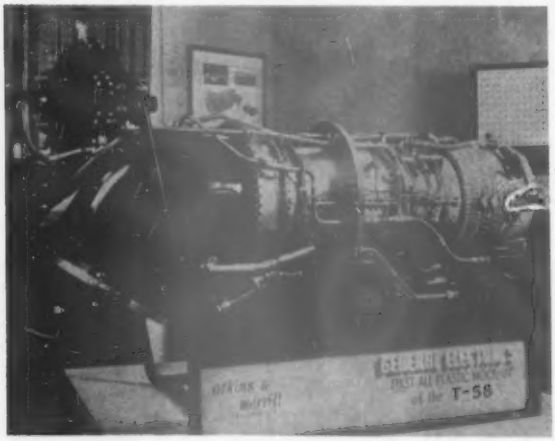
Gel coatings are relatively thick in nature and preclude surface bubbles which may arise during subsequent laminating.

As soon as the gel coating becomes tacky, the glass cloth tapes or panels and laminating resins are applied over covered areas. This assists the retention of the resin on vertical surfaces, and lends considerable strength and stiffness to the final welding fixtures. The unit is then allowed to harden, with room temperature cures preferred, though faster heat cures are practical.

To assure proper use, most epoxy laminated materials for tooling are prepared by experienced resin formulators well acquainted with industrial requirements, and who will assist tooling establishments in applying materials.

When properly used, typical properties of a laminated structure using a tooling grade of glass cloth include a 1.6 density (times the density of water) of laminate, 32,000 psi flexural strength, and 1,900,000 modulus of elasticity in flexure.

In the design and preparation of welding fixtures, steel reinforcements and heat sinks may be desirable. Whether steel channels are held in place by glass cloth and epoxy for



EPOCAST laminating and casting resins were used in fabrication of plastic model of T-58 turboshaft engine. All-plastic model was originally produced to check fit and assembly of parts, but unit is also serving as model for alignment procedures.

LAMINATED spot welding fixtures are fabricated to duplicate sheet metal model, with openings left for insertion of spot welding electrodes. Here, turbine scroll components are being spot tacked. Parts were produced by Solar Aircraft Co.

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SPOT tacking on an instrument panel section at Solar.

stiffening, or whether drill bushings are to be inserted, the resins will form a part of the welding fixture and be coordinated into a workable unit.

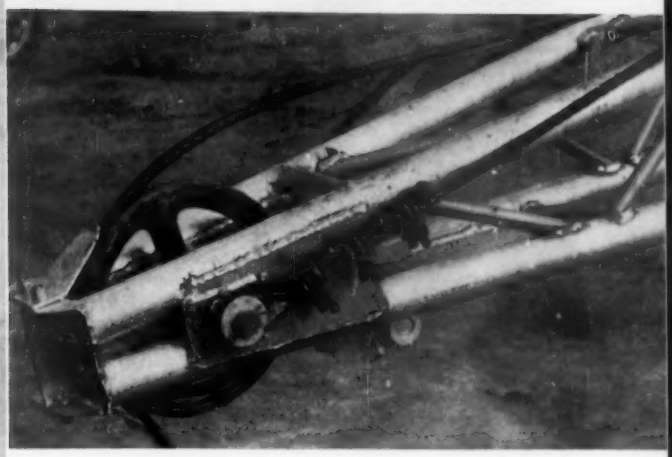
Laminated epoxy welding fixtures have considerable advantages over metal fixtures. The plastics are lightweight, making handling easier. Their insulating properties are high, and when properly fabricated using correct formulations, dimensional stability is excellent. Also, the non-scoring qualities of epoxies prevent special surface finishes from being marred or scratched.

Laminated epoxies can no longer be considered temporary tooling because after several years of severe service in various industries, laminated epoxies have been accepted as production tooling aids replacing many metal fixtures. One reason is that with the active assist of an accurate model or assembly, the conformal reproduction of the epoxies bypasses many costly machining hours usually needed with metal fixtures.

A striking example of the strength, stability and excellent qualities of epoxy laminations is the all-plastic model of the T-58 turboshaft engine fabricated by Atkins & Merrill Inc.

Epocast laminating and casting resins were used to produce the engine primarily for checking the fit and assembly of components. However, the structure is also able to suggest to the welding engineer alignment procedures for metal parts, serving in effect, as a three dimensional model.

TALLEST boom in North America, 10-story-high aluminum structure was Mig welded from 4,500 ft of tubing. Angle jib (below) adds 30 ft to overall length of 140 ft.



by **Earle H. Weichel**

They said it couldn't be done—but...

Aluminum boom used for construction in Canada

"IT CAN'T BE DONE." This was the reaction of countless contractors to the idea of a welded aluminum crane boom—the brain-child of two Waterloo, Ontario, firms.

But the 140-ft-long boom and jib—tallest in North America and possibly the world—is now out on jobs around the Ontario environs.

This 10-story-high aluminum boom is the work of Carter Brothers, Ltd., and W. R. Petri, consulting engineers, two firms which have cooperated in the past two years to score several "firsts" in aluminum construction, *e.g.*, the first welded aluminum dump and semi-trailer truck bodies in Canada, the first all-aluminum dredgers, the first aluminum conveyor bridge in North America.

It took another local firm, however, to give this scoffed-at plan the needed impetus. Craftway Equipment, Ltd., ordered the boom for a Kitchener, Ontario, construction firm. In four weeks the 4,500 ft. of aluminum tubing was fabricated and assembled.

The boom's main section measures 110 ft and is 60 x 48 in. at its widest point; an angle jib adds another 30 ft to the overall length.

Top and base of the main boom are each 20 ft in length. Four 20-ft sections and one 10-ft section allow for increasing the boom length to its limit in increments of 10 ft; could reach 170 ft in length on a heavier crane.

Loads for the 25-ton crane are; with the 30 ft jib, 6-in. offset:

Radius	*Boom center*	*Load*
25 ft	40 ft	15,000 lb
50 ft	100 ft	5,500 lb
80 ft	130 ft	1,800 lb

Lower final costs with aluminum welding materials from ALCOA

Your Guide to the Best in Aluminum Value

ALCOA ALUMINUM

No matter how you join aluminum—by welding, soldering or brazing—you can lower the cost and improve the quality of your end product if you use materials from Alcoa. The reason: rigid quality controls and thorough testing that go into all Alcoa welding materials assure you of more sound welds and fewer rejects.

But, as a supplier, Alcoa does more than furnish first-quality materials. Alcoa also offers you the benefit of extensive research in alloys, welding techniques and joining methods. From design to production, this single source can work with you to answer any joining requirement, no matter how large or small.

Consider this complete line of welding materials from Alcoa:

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IG (INERT GAS) WELDING ELECTRODE: For the consumable electrode, inert gas shielded metal arc welding process. Available in a wide variety of alloys, level wound on 10-lb and 1-lb spools.

COILED WELDING ROD: Available in standard mill-wrapped coils approximately 55 lb in weight. Etched or commercial finish; several alloys are available for immediate delivery, others fabricated on request.

STRAIGHT-LENGTH WELDING RODS: Thirty-six-inch straight-length welding rods, packed in 5-lb tubes; 10 tubes to a standard shipping carton. Other alloys and sizes fabricated on request.

WELDING FLUX: Available in jars of 8 oz, 1 lb, 5 lb; drums of 50 lb and 150 lb. General use is for oxyacetylene or oxhydrogen gas welding. No. 22 flux, colored deep pink to facilitate identification.

BRAZING SHEET, ROD AND FLUX

BRAZING SHEET: Made as a one- or two-sided clad product with the filler metal integrally bonded to a core alloy, or in the form of shim stock of a brazing filler alloy.

COILED BRAZING ROD: Standard wrapped coils with etched or commercial finish in sizes from ¼-in. to 1/16-in. types available for standard or specialized brazing operations.

STRAIGHT-LENGTH BRAZING RODS: Thirty-six-inch straight lengths packed in 5-lb tubes, 10 tubes to a standard carton. Sizes from ¼ in. to 1/16 in. May be applied either by flowing into the joint when torch brazing or as wire rings or other shapes when furnace or dip brazing.

BRAZING FLUX: Four types available, color coded for identification purposes. Available in packages ranging from 8-oz jars to 150-lb drums to fill any brazing requirement.

SOLDERING SHEET, SOLDER, SOLDERING FLUX

SHEET: Zinc-coated aluminum sheet, clad on either one or two sides. This new product permits easier joining and provides maximum resistance to corrosion.

SOLDER: Two types available for low- or high-temperature applications. Available in a variety of spool and stick sizes; high-temperature solder can be used to join aluminum with copper, brass, steel, stainless steel, nickel, etc.

SOLDERING FLUX: Several types available for use with both high- and low-temperature solder. Available in packages ranging from 1-oz bottle to 150-lb drum.

Any of the distributors listed can give you full information on aluminum welding and brazing processes. **Also, a number of films** are available from Alcoa on a loan basis. Further information is available from **Aluminum Company of America, Pittsburgh 19, Pa.**

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

Want technical help in welding, brazing or soldering aluminum? Contact your Alcoa sales office, listed under "Aluminum" in the Yellow Pages of your phone book.

For immediate delivery of Alcoa welding products, call your Alcoa outlet listed below. He carries a complete range of alloys and sizes.

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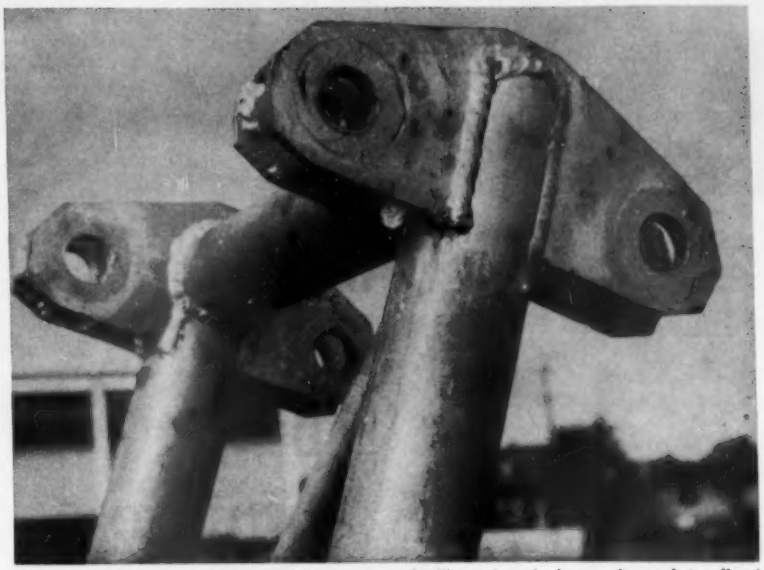


WELDED tubular section juts out between angle jib and main boom; is used to direct hoisting cable via holes.

with the main boom only:

12 ft	40 ft	50,000 lb
50 ft	100 ft	7,200 lb
80 ft	130 ft	2,300 lb

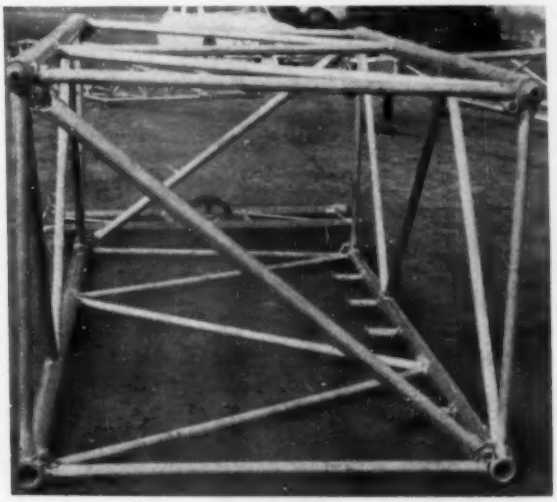
Cord members for the main boom are 4-in OD, 65 S-T aluminum pipe with a wall thickness of 0.318 in. Struts measure 1.66-in. OD with wall thicknesses of 0.140 in. The jib section uses the same type aluminum piping, 2-in. OD with a 0.154-in. wall thickness. The jib struts are 1.05-in. OD, 0.1133-in. wall thickness.

The increments, or sections, are held together by spriggot and bolt type joints. Joint parts of the aluminum castings are Mig welded using type 56S wire. Female and male aluminum sand castings of 123 alloy, which has excellent elongation without heat-treatment, make up the joints between sections.

Advantages of the aluminum boom over regular steel are easily seen. A steel boom of this length would weigh some 8,000 lb; the aluminum boom weighs only 2,600 lb—increasing the payload by 5,400 lb.

Sections are easily lifted; no painting or other maintenance is required. The full-length boom can be lifted from the ground, whereas a steel boom must be hoisted 30 ft before the crane takes over the lift.

According to Petri, the aluminum boom also has a 9-1 safety factor over a steel structure. If it is dropped, it bounces back; a steel boom would bend or break.



ONE SECTION of boom shows female and male joints. Top and base section are 20 ft; increments are 20 and 10 ft.

INSTALLATION of a 4,500-ft gas transmission line using 40-ft lengths of alloy 6063-T6 aluminum pipe. Here, sections are being positioned prior to welding on new automatic pipe welder.

Aluminum has bright future in piping industry

SECTION of new line—part of gas gathering system—is positioned in welding machine. When joint is completed, pipe is pulled through machine. Pipe was buried without coating or wrapping.

ALUMINUM PIPELINES have a bright future because of two recent developments by Aluminum Co. of America, Pittsburgh.

The first, devised for efficient welding, is a seamless, one-piece tube having a heavier wall thickness at pipe ends than along the length. The second advancement is a welder able to produce sound welds, with full penetration, without the use of back-up rings.

Using both new tube and welder, Alcoa recently completed a 4,500-ft, 8-in. pipeline at its Point Comfort, Tex., operation. The aluminum pipe was buried without protection, and cost only 4% more than coated and wrapped steel lines of comparable size.

The manufacturer feels the extra cost is overcome by aluminum's high corrosion-resistance, maintenance of product quality, and non-sparking characteristics.

Piping used is schedule 40 in alloy 6063-T6. Nominal wall thickness at pipe ends is 0.322 in., while along the length it is 0.204 in. Varying the wall thickness cut pipe cost 20%, compared to similar lines installed prior to this development.

The automatic welder did its part in laying the line, too, making 8-in. circumferential welds in 17 seconds. Such speedy operation helped to further cut the cost differential between aluminum and steel piping.

Lavaca Pipe Line Co. installed the line, welding 112½ forty-ft sections of pipe. The line carries dry gas at a pressure of 500 psi, and conforms to the ASA code for pressure piping. (More photos on p. 74.)

save!

Push the button—and save up to 10% on oxygen costs, up to 30% on fuel gas costs . . . with SMITH'S money-saving push button gas control unit! Two additional advantages: it saves on labor costs—16% in a typical case history . . . also improves cutting quality by reducing burnover; improves welding quality by reducing pinholes and slag inclusions and gives better puddle control. SMITH'S gas control unit instantly reduces the high pre-heat flame you need to start many cutting, welding, silver soldering, production brazing, and heating operations to the lower flame you need to complete them. Makes an ideal shut-off valve for inert gas welding, heavy heating and flame hardening equipment. It works on a solenoid-operated valve, plugs into any 110 volt outlet. Use with as many as 8 machine torches (pays for itself over and over again). Available with either hand or foot operated remote control for maximum convenience. See your welding supply distributor, or write:

PUSH-BUTTON GAS CONTROL

SMITH WELDING EQUIPMENT CORPORATION

2623 Fourth Street S. E.,
Minneapolis 14, Minn.

ENGINEER makes final adjustments on head of automatic welder. High speed unit completes one pass on 8-in. pipe in 17 seconds, without use of back-up rings.

ALUMINUM outrigger supports 40-ft section of pipe. Outrigger, made by company's job shop, simplifies lining-up process by permitting delicate vertical adjustment to be easily made.

COMPLETED weld joins two 40-ft sections of pipe. After welding, joint is brushed, as at right, and inspected. Pipe carries dry gas at pressure of 500 psi.

ADVANTAGES of aluminum pipe was proved 2½ years ago when Alcoa installed 20,000-ft line at Point Comfort. It lays in marshy soil, yet shows no signs of deterioration.

INSIDE *and* OUT...

NOW

MORE COMFORTABLE
MORE DURABLE
...and safer than ever!

EXCLUSIVE

POLYETHYLENE DUAL SUSPENSION
strong, pliable, comfortable, easy to clean

The BIG NEWS from FIBRE-METAL is a DOUBLE FEATURE:

1) The polyethylene Suspension is a *single unit* composing both a "fixed" safety factor as well as an "adjustable" clearance from the shell. EACH ONE, INDIVIDUALLY, PASSES FEDERAL SPECIFICATIONS! The entire Suspension, including the headband, is soft and pliable for comfort, rugged for safety, clean in design that stays clean and is easy to clean.

2) The Shell has an added "veil" of fine glass fibres that achieves a thin layer of resin and glass fibres close to the surface for superior weathering and abrasion resistance.

These "two features" are exclusive with FIBRE-METAL!

OTHER FIBRE-METAL FEATURES

3) New "flush buttons" in shell and headband increase wearing comfort

4) Polyethylene Suspension will not mildew, sour or rot. Easily cleaned or sterilized. Unaffected by detergents.

5) Headband of softly pliable polyethylene conforms to head...adjusts to any head size from 6⅝ to 8.

6) All edges of suspension rounded for comfort.

7) Laces are recessed to prevent discomfort ...and to adjust for depth.

8) Triple adjustment of headband to *raise, lower or tilt* headband to increase individual comfort or to adjust for adverse work conditions.

9) Provision for chin strap in every hat and cap.

This NEW DUAL Suspension is interchangeable in *SuperGlas, SuperLite* and *SuperLectric* Hats and Caps...and is interchangeable with all Fibre-Metal Suspensions in the field.

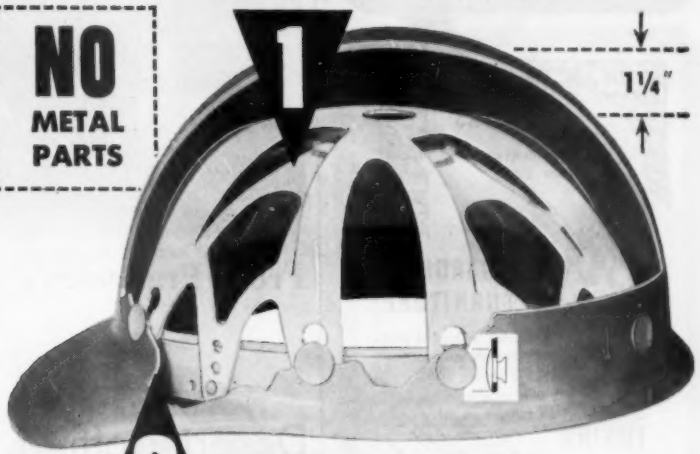
OVER 52 YEARS OF WELDING & SAFETY

NEW "**DUAL** *SUSPENSION" for SAFETY*

NO METAL PARTS

1

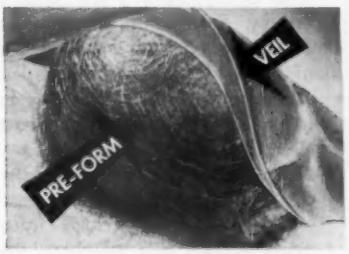
1¼"



NEW **2** "**DUAL** *FIBERGLAS" SHELL for DURABILITY*

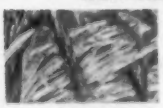
Headband of softly pliable polyethylene conforms to head...ADJUSTS TO ANY HEAD SIZE from 6⅝ to 8.

SUSPENSION REMOVABLE, but ONLY headband-sweatband need be replaced...saves time and 30% replacement cost. No dangerous metal parts.

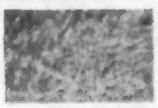


DUAL FIBERGLAS! The fine glass fibre "veil" achieves a thin layer of resin and glass fibres close to the surface for superior weathering and abrasion resistance.

PROVED BY 14½ MONTHS WEATHERING TEST



View of an ordinary safety hat shell surface after 14½ months of actual weathering in sun, wind and rain...24 hours a day.



Here's the nearly new look of Fibre-Metal's SuperGlas Shell after 14½ months of weathering. Abrasion tests show similar results.

ASK YOUR WELDING & SAFETY SUPPLY DISTRIBUTOR FOR BULLETINS

THE FIBRE-METAL PRODUCTS COMPANY

CHESTER, PENNSYLVANIA
In CANADA: Fibre-Metal (Canada) Limited, Toronto

the fabricators
SUPER MARKET
Everything
FOR THE
O. I. SHOP

CASTINGS
Over 400 designs to choose from.

GARDEN FURNITURE
Great traffic and profit builders, many styles to choose from.

TUBING
From one tube to a mill lot.

PAINT
Specially designed for O. I. use.

WELDING RODS
Give spatter-free welds require little clean-up

MACHINE TOOLS AND SUPPLIES
Everything your shop would need.

OVER 400 CASTING DESIGNS

Orders shipped same day, by air if requested.

WRITE TODAY FOR OUR NEW CATALOG

TFC

TENNESSEE FABRICATING CO.
1444 Grimes St. Memphis, Tenn.

From France . . .

Desert-trotting, all-welded truck is world's largest

NOT ALL AUTOMOTIVE products coming from Europe fall into the Lilliputian category—some qualify for the Gulliver classification.

One of these, the all-welded Berliet T100 truck, was on display at the recent International Trade Fair at Chicago's Navy Pier.

Designed for use during industrial development in the Sahara desert by French oil companies, the 100-ton giant has an overall width of 16 ft, 4 in.; is 42 ft in length; stands a total of 13 ft, ½ in. in height. A final idea of its extreme size: the six tires each have an overall diameter of 7 ft, 9 in., and the tire tread is 38 in. wide.

The sturdy arc-welded frame is made of two side members, each a 6 in. by 20 in. I-beam section, braced by two tubular cross-members at the center and a box plate girder in the rear. The top and bottom sections of the box girder are 1 in. by 6 in. plates while the side plates are 17¾ in. by ⅝ in.

Powered by a 600 hp Cummins diesel engine, the 30-40 ton payload capacity truck is a rugged off-the-road vehicle. And since it will be used on trips taking it hundreds of miles from civilization into desert areas where prevailing temperatures are 131 F, the all-welded steel cab was designed to meet all climatic conditions with the best conveniences for driver and crew.

With sleeping accommodations for five passengers, the cab is also equipped with an air-conditioning unit, a cooking range and refrigerator, drinking-water tank, electric current for appliances, etc. There is even a 200-mile-range, two-way radio so the crew can keep in touch with base headquarters.

The flat, loading platform of the particular model displayed has a grooved metal floor supported by a metal frame of beams and angles welded together and attached to the chassis. The platform measures 26 ft, 6 in. long, by 15 ft, 5 in. wide for a total surface area of 323 sq ft.

Without a doubt, the truck is easily the world's largest, and welding made it possible.

GOLD STAR SR

This d-c rectifier type welder does more things better than any other welder of its class because —

a. Its new transformer (Miller designed and built) has integral flux diverter.
b. Its new weld stabilized circuit delivers the ultimate in speed of metal deposition.
c. Its new completely sealed semi-metallic rectifier — designed for welding — provides the most efficient d-c for welding ever devised.

These features contribute to the Gold Star SR's greater arc stability, denser welds, easy arc starting and flexibility to handle all electrodes in all positions.

Performance-proved wherever profits are important, the Gold Star SR is available in single and duplex models of 200 to 1200 amperes at 60% duty cycle ratings.

"... if it's MILLER you know it's the finest..."

GOLD STAR *All-Weather* SRH

The features that set the SR above and beyond the normal standards of welder performance belong to the SRH also. But, in addition to the horizontal design for easier stacking and paralleling, this welder has an "all-weather" construction that includes baked varnish coated transformers and rectifiers plus phosphatizing and painting of all base and sheet metal — even fan blades. Cam-Lok receptacles are standard equipment. The Gold Star SRH welds real well.

Complete specifications on these Gold Star models will be sent promptly.

miller Electric Manufacturing Company, Inc., APPLETON, WISCONSIN

EXPORT OFFICE: 250 West 57th St., New York 19, N.Y. • Distributed in Canada by Canadian Liquid Air Co., Ltd., Montreal

News shorts . . .

Linde Co., New York City, will build a plant to supply cryogenic fluids for the missile engine production facilities at Fort Crowder Reservation, Neosho, Mo. When finished next year, the plant will produce 135 tons of liquid oxygen and nitrogen daily. **Crow-Garrick Co.,** Ventura, Calif., has placed in operation a Linde liquid oxygen storage and distribution facility. Also, a Linde distributor, **Benson & Zimmerman,** Modesto, Calif., has been sold to **J. P. Livingston,** former Linde assistant manager. The new firm is **Livingston Oxygen and Equipment Co.**

Brennen, Bucci & Weber, Inc., has changed its name to **Bren Weld Corp.,** and has moved its offices to 5114 Third Ave., Brooklyn. . . . **Air Reduction Sales Co.,** New York City, is building a $140,000 sales office and warehouse at 1250 Military Rd., Tonawanda, N. Y. It will replace company quarters at 730 Grant St., Buffalo. . . . **All-State Welding Alloys Co.,** White Plains, N. Y., is aiming to triple its production capacity for spooled aluminum wire. New spooling machines are being installed at the White Plains and South Gate, Calif., plants.

National-U.S. Radiator Corp., Johnstown, Pa., has purchased **Magnetic Powders, Inc.,** Johnsonburg, from **Radio Cores, Inc.,** Oak Lawn, Ill., to aid its Plastic Metals Div. in manufacturing metal powders used in electrode coatings and other products. . . . **Chester S. Johns,** general sales manager of **Buhr Machine Tool Co.,** Ann Arbor, Mich., spoke on the handling of production and sales of automated lines at the recent Detroit meeting of the **Resistance Welders Manufacturers' Association.**

Chicago Bridge & Iron Co., Chicago, has formed a Netherlands company to erect large steel plate structures fabricated in that country. Headquartered in Rotterdam, the new firm is **Chicago Bridge (Nederland) N. V.** Also, CB&I has been awarded a $475,000 contract for the fabrication and erection of 16 fuel storage tanks for Chicago's O'Hare International Airport. Aggregate capacity will be 120,000 barrels.

A $140,000 deep freeze as large as a room, has been installed at **North American Aviation Inc.'s** Columbus, Ohio, plant by **Tenney Engineering Inc.,** Union, N. J. It is used in new method of fabricating honeycomb wing sections for jet aircraft. After brazing at 1,650 F, sections are air cooled to 100 F and frozen. (Picture at right.)

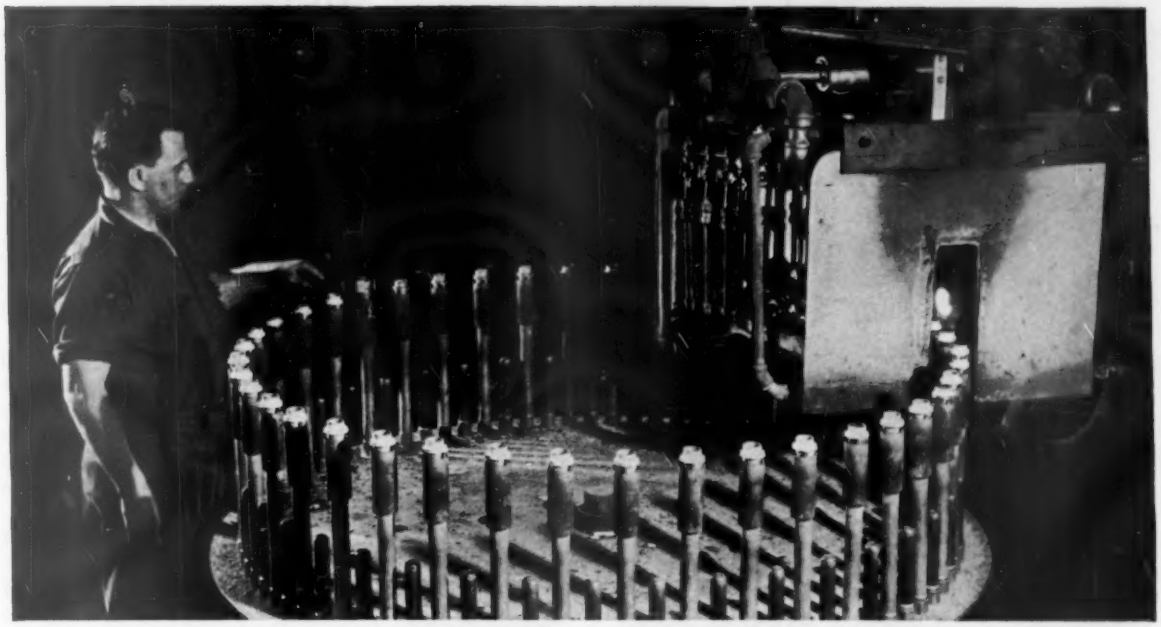
Crucial problems in the field of nuclear metals will occupy a full-day international symposium at the annual fall meeting of the **Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers,** to be held November 2-5 in the Morrison Hotel, Chicago.

The **U. S. Atomic Energy Commission** and **West Virginia University** will co-sponsor a two-day workshop on industrial uses of radioisotopes in Morgantown, Nov. 19-20. The AEC has awarded a contract to **Kaiser Engineers, Div. of Henry J. Kaiser Co.,** Oakland, Calif., for a study of the potential use of nuclear power at remote military installations. Study will cost an estimated $515,000. . . . The corporate name of **Norton Behr-Manning Overseas Inc.,** has been changed to **Norton International Inc.**

Food Machinery and Chemical Corp. Ordnance Div. has placed initial orders for aluminum ballistic armor plate to be used in the first models of the M-113, the Army's new personnel carrier. The plate, weldable aluminum alloy 5083, was developed by **Kaiser Aluminum & Chemical Corp.,** Oakland, Calif.

O. S. Walker Co., manufacturers of magnetic chucks, has acquired the principal assets and all patents of **Buck Mfg. Co.,** San Jose, Calif. . . . **Fairmount Chemical Co., Inc.,** manufacturers of hydrazine and its derivatives, has moved its main offices to 117 Blanchard St., Newark. . . . Ground has been broken in New York City for the United Engineering Center. The 18-story structure will house headquarters of 18 engineering societies.

Every Hour M. S. Little Brass Goods Company Makes 650 Appliance Fittings Better With HANDY & HARMAN SILVER BRAZING



Rotating jig showing mounted assemblies entering and leaving gas-air furnace.

Left– brazed assembly. Right– components with preform ring of EASY-FLO *45.*

This Hartford, Connecticut, company makes—in volume—an assembly that goes into the overflow system of household appliances. The assembly consists of brass tubing and a machined brass casting. The two components are joined by a preplaced ring of Handy & Harman EASY-FLO 45 silver brazing alloy and HANDY FLUX. Heating is automatic gas-air; parts are placed on a rotating turntable to pass through the gas furnace. Every 60 working minutes, 650 assemblies are completed.

The advantages here are that the manufacturer can use thin-walled tubing with heavier, threaded components at no sacrifice in strength. Because of EASY-FLO's penetrating qualities, the entire shear area is fully as strong as the solid parts of the assembly, yet considerably lighter. And, casting and machining the components for this assembly have been greatly simplified.

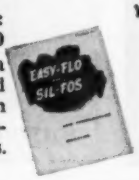
Are you in pursuit of a metal-joining method which offers—among other advantages—high, uninterrupted production at low capital investment? You may easily find the answer in Handy & Harman silver brazing. Hundreds of manufacturers and fabricators of as many different products, parts and components are right now enjoying the speed, economy, strength and *flawlessness* of brazing. You can too. Just ask Handy & Harman, 82 Fulton Street, New York 38, N. Y.

COMING IN NOVEMBER!

New Handy & Harman Brazing Correspondence Course. Simple self-study data on all phases of brazing. Send for details to Dept. BC.

FOR A GOOD START: BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits... includes details on alloys, heating methods, joint design and production techniques. Write for your copy.



Your No. 1 Source of Supply and Authority on Brazing Alloys

HANDY & HARMAN

General Offices: 82 Fulton St., New York 38, N. Y.

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Toronto, Canada

Located 1,075 miles above the earth and traveling 15,840 miles per hour in surroundings where there is no atmosphere or weight, where the sun's rays may heat an object to 4,000°F., and where hazards like cosmic radiation are ever-present, will be Space Station #1 — the construction site for the first moonships.

Can existing welding methods be employed on these moonships under such environmental conditions? What special welding equipment will be needed? In preparation for man's first trip to the moon, RACO engineers are researching these and other critical space age questions. For forty years, RACO has touched on the borders of tomorrow, anticipating and meeting the diverse welding needs of industry.

RACO utilizes the most advanced automation techniques to produce all grades of precision welding wire drawn to rigid metallurgical specifications, and a complete range of welding electrodes engineered to fulfill all requirements with complete reliability.

Welding Reliability Begins with RACO

RACO

REID-AVERY COMPANY, INC. DUNDALK, BALTIMORE 22, MD.

Write today for the complete RACO catalog.

Silver-bearing soldering flux puts stopper on damaging hard-water

by **Charles Bastion**
All-State Welding Alloys Co.

THE THREE R's may be the most important ingredient in a school's educational program, but when it comes to the building itself a good watertight heating system is surely one of the fundamentals.

When Jefferson Elementary School was under construction at Mount Vernon, Washington, lime and other chemicals in the local water caused lead-based solders to oxidize. Failure of pipe joints threatened the entire heating system.

The plumbing and heating contract was given to the Diamond B Plumbing Co. of Bellingham. It had to find the best way to join copper pipe in sizes from ½ in. to 4 in. in diameter, and to join copper piping to an iron boiler.

After failure of the lead based solders, a standard silver solder was tried. Trouble was encountered when heat required for melting the solder

PORTION of boiler and plumbing installation at Jefferson, installed in 1955.

SILVER-bearing solder and non-acid flux were used to make permanent copper pipe joints.

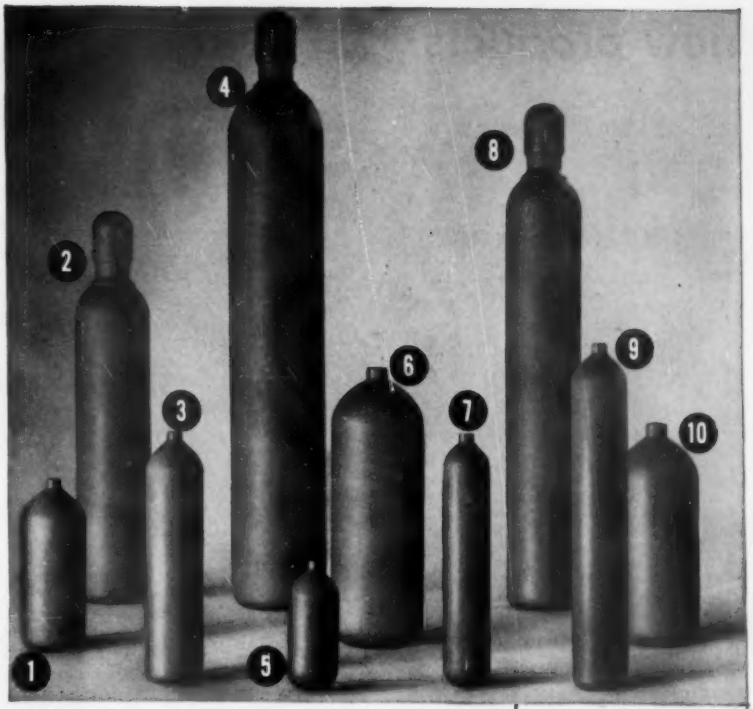
(minimum 1100 F) caused copper tubing and fittings to burn. Phos-copper and phos-copper-silver solders were also unsatisfactory.

Diamond B's welding supplier recommended a silver-bearing solder designated #430 by the manufacturer. The solder contains no lead, zinc or cadmium and flows freely at 430 F. It, and a non-acid flux did the job, making joints in the entire range of sizes, and joining the copper hot water lines to the iron boiler.

Cost records of the job show that an average of four joints were made with the solder to one with the other compositions tried. One plumber, inexperienced in brazing piping, was able to make sound joints even in hard-to-reach places.

The school was completed in 1955. Recent inspection of pipe joints indicates that fittings are as watertight as the day they were installed.

PAUL Johansen, Jr., of Diamond B, inspects 2½-year-old joint in 2-in. copper pipe.



Choose high-pressure gas cylinders from the HACKNEY "Family"

Shown here are ten popular Hackney high-pressure gas cylinders for industrial and medical services.

They are popular because they more than pay their way through long, maintenance-free service.

Lightweight, without sacrificing safety, strength or durability, Hackney deep drawn cylinders:

- save money on shipping costs
- reduce handling costs
- cut maintenance costs—smooth surfaces clean easily, paint quickly
- provide full capacity—no need for complaints
- require minimum storage space per cylinder
- earn customer good will—attractive appearance in doctors' offices, clinics, hospitals, etc.
- permit you to serve *all* customers with cylinders of the size they need
- exceed all ICC specifications

1. 5-lb. CO_2 5¼" x 13⅜"
2. 80 cu. ft. oxygen 6⅛" x 32½"
3. "D" Medical 3⅝" x 16¾"
4. 250 cu. ft. oxygen 8⅝" x 51"
5. "A" Medical 3⅛" x 7⅞"
6. 20-lb. CO_2 7.45" x 23¼"
7. 11 cu. ft. oxygen 3⅜" x 18⅞"
8. 110 cu. ft. oxygen 6⅝" x 43"
9. "E" Medical 3⅛" x 25¾"
10. 10-lb. CO_2 6½" x 18⅝"

SEND FOR NEW BULLETIN. Gives complete facts about Hackney manufacturing features, range of capacities and sizes, ICC specifications, and other helpful information. Write:

Pressed Steel Tank Company

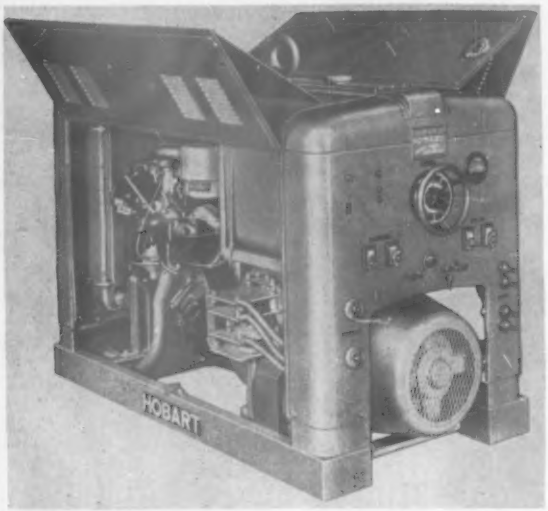
Manufacturer of Hackney Products Since 1902

1456 South 66th Street, Milwaukee 14, Wisconsin

Branch offices in principal cities

Hackney

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS



Welder and power unit

Gasoline-engine driven arc welder and power unit is designed especially as a source of power for Tig welding. With only one engine and one generator, the machine provides current for either a-c or d-c welding. It is rated at 250-amp, 30-volts for d-c and 300 amp, 30 volts for a-c welding. As a power source, it produces single phase, 110/220 volt a-c power of 10 KW capacity or one KW, 110 volt auxiliary d-c power during welding. Mounted on the control panel are four 110 volt a-c receptacles, two 220 volt a-c 3 wire twistlocks, one 110 volt d-c receptacle and a special receptacle for a Tig package unit. *Hobart Bros. Co.*

Circle No. 1

Power supply

Model 100 power supply is designed for use with company's Arc Spot weld gun to insure automatic time control shut-off of the arc. Weighing 40 lbs, the unit operates on 110 v on a 30 amp fuse. Other voltages are available. *Bren Weld Corp.*

Circle No. 2

Plasma jet equipment

Plasma Flame units are now available for production of hot gas streams to 30,000 F for many various industrial applications. Operating costs are half that of an oxygen flame, and the life of the equipment is said to be 50 times that of similar apparatus. Available in power levels ranging from 12 to over 1000 KW, the plasma units are furnished as complete systems or individual components. *Thermal Dynamic Corp.*

Circle No. 3

Spark erosion electrode

Sparkal-X electrodes have use in joining hard-to-weld metals and in spark machining. The electrode showed greated volume of metal removed per time unit and greater volume of metal removed per volume of electrode loss than other materials in comparison tests, says manufacturer. *Saturn Metallurgical Industries.*

Circle No. 4

HI-AMP

ELECTRODE HOLDERS
CABLE ATTACHMENTS
GROUND CLAMPS

Offers

T.P.C.*

* THREADED POWER CONNECTION

Excessive heat in a welding circuit is oftentimes caused by a resistance build-up at some point in the welding circuit due to connections being loose or oxidization setting up in a mechanical type of terminal connection.

Shown in the above "cut-a-way" picture of an Electrode Holder is the new HI-AMP, T.P.C. type of connection that can be adapted to ground clamps and quick disconnect plugs as well as to electrode holders.

T.P.C. means a Threaded Power connection using the pressure of threads on a sleeve to drive the ends of any welding cable down into the depth of a cable socket, then locked into place with threaded plugs. An excellent electrical connection as well as providing direct contact with the welding cable to the accessory so that maximum heat is conducted into the heat-absorbing cable.

ASK YOUR WELDING SUPPLY HOUSE FOR FURTHER INFORMATION

354 W. ADAMS ST. LENCO, INC. JACKSON, MO.

NEW FROM TEC

THE NEW TEC AIR-COOLED TORCH!

MODERN DESIGN BY TEC

Tec research and endless testing have provided an easy handling and smooth, effortless operating, the most up-to-date air-cooled torch on the market.

USER MINDED ECONOMY

Tec Visuweld transparent Gas nozzles (both standard and off-set) and Tec chucks are interchangeable with the new air-cooled torch . . . no need to stock or store new parts.

GAS SAVING ECONOMY, TOO

Preliminary testing has already indicated that considerably less gas with greater coverage is afforded with the new air-cooled.

RUGGED CONSTRUCTION

Durable and long lasting due to one piece construction of phenolic plastic reinforced with macerated fiber glass.

Contact your local distributor or write:

SPECIFICATIONS

Engineered to most efficient performance.

MODEL 3110 (Pencil Grip)
Rated Capacity:
Continuous duty cycle: 80 Amp.
Reduced duty cycle: 100 Amp.
Overall length: 9¾"
Handle diameter: 1 inch.
Maximum electrode length: 6 inches.
Electrode diameter: .020, .040, .0625.
Cable lengths: 12½ or 25 feet.

MODEL 3330 (Pencil Grip)
As above except:
Rated Capacity:
Continuous duty cycle: 130 Amp.
Reduced duty cycle: 150 Amp.
Electrode diameter: .020, .040, .062, .093.

MODEL 3220 (Angle)
Same as 3110 except:
Overall length: 8 inches.
Handle diameter: 1 inch.
Electrode length: 3 inches.

MODEL 3440 (Angle)
As above except:
Rated Capacity:
Continuous duty cycle: 130 Amp.
Reduced duty cycle: 150 Amp.

TEC TEC TORCH COMPANY, INC., CARLSTADT, N. J. MANUFACTURERS OF VISUWELD EQUIPMENT

VALUE VERSATILITY

···you get more of both in the

PUROX TRADE MARK "E" Cutting Torch

When LINDE first offered the PUROX "E" Torch to industry, Ford's model T automobile sold for less than $500. Today's average car costs at least 350% more. *But the price of the "E" torch has gone up only 22%.* Since practically every part in it has been refined for improved performance and longer life, the PUROX "E"—granddaddy of cutting torches—is still one of the biggest oxy-acetylene apparatus values to be found anywhere.

Whatever your present requirements, there's a PUROX "E" Torch to take care of them. Choose a head angle of 75, 90, or 180 degrees in standard 20½-in. length, or a 36-in. model with 90-deg. head. Should new or special needs develop at any time, any model can be adapted to meet them by simply replacing the front-end assembly.

With four interchangeable front ends and 57 different nozzles, the PUROX "E" Torch easily handles any practical hand-cutting job. It cuts steel up to 12 in. thick, washes pads, cuts rivets, gouges, and pierces. *And it performs efficiently on acetylene or any other commercial fuel gas available.*

See the PUROX "E" Torch today at your LINDE Distributor's. Or write for free folder, F-1313. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited, Toronto.

Linde Trade Mark

UNION CARBIDE

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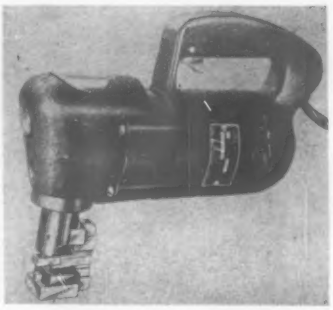


Portable nibbler

Nibbler uses punch-and-die action to cut 14 gage stainless and 13 gage mild steel without distortion of either side. Weighing 8 lbs, Model MN can cut practically any kind of hole in places inaccessible to other equipment, states manufacturer. It is correctly balanced for easy hand-held operations. *Fenway Machine Co.*

Circle No. 5

Resistance welder

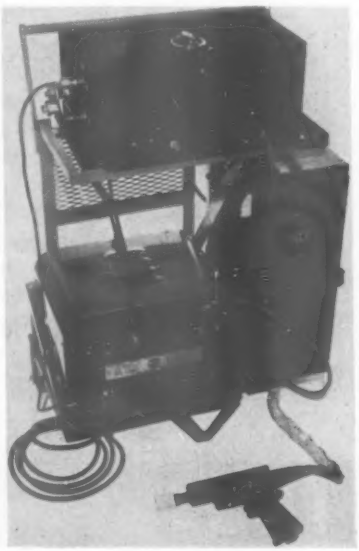
Model BHA single-phase butt welder features newly developed horizontal "pull-in" rams of light-weight aluminum, operating in lineal ball-bearing sleeves. Along with uninhibited ram action, the unit also has the Heat Vector control, which is said to give 3-phase welder performance in the single-phase machine. The BHA is produced with KVA ratings of from 5 to 100. *Universal Electroweld Div.*

Circle No. 6

Portable spot control

Spot control unit, with the addition of d-c power source, makes spot welding accessible at the point of work. Consisting of a Tec spot gun, spot control panel, high-frequency unit and a heavy-duty contactor, the control is mounted to a heavy-duty frame truck. *Tec Torch Co., Inc.*

Circle No. 7



Hardfacing electrode

Manual tubed electrode, Amsco 53, is designed for general purpose hardfacing. Featuring a stable, low-spatter arc, the electrode is said to be smooth running and high speed, with excellent buildup. *American Manganese Steel Div.*

Circle No. 8

Cut-off machine

Oscillating-type abrasive cut-off machine operates on the see-saw principle to cut I-beams in sizes to 36 by 12-in. Available are three models—20 in. wheel, 26 in. and 34 in. with respective hp ratings of 15, 20 and 40. The first two machines can operate dry while the latter is wet only. Very fine finish and high speed cutting are claimed for these units. *Wallace Supplies Mfg. Co.*

Circle No. 9

Pressure regulator

Model No. X25 regulator is a low-cost, single-stage unit which will handle 2,000 cfh, enough to cut 14 in. steel with only 2 lb. drop from no flow to flow. Accurate pressure regulation is assured by the 2¾-in. diaphragm area, and the soft valve seats minimize seat leak or creep. Regulators are available for all common gases. *Harris Calorific Co.*

Circle No. 10

Induction heater

Remote operated dual-output induction heater has work coils which can be moved as far as 50 feet from the generator, simplifying operations on unwieldy work. Equipped with a dual output station and two flexible, low-loss, high-frequency coaxial cables, the unit and its accessory equipment are shock-mounted on a mobile platform. Electrical interlocks on each coil prevent concurrent operation, and an indicator light shows which coil is in use. The remote control pendants are located alongside the operator. *Induction Heating Corp.*

Circle No. 11

Combination cloth

Ventcloth, combination bleeder cloth and parting film, finds use in vacuum-bag molding operations. Consisting of a woven glass fabric impregnated with an efficient parting agent, the cloth may be utilized in metal bonding also states manufacturer. *Narco Resins & Coating Co.*

Circle No. 12

D-C welder

Diesel driven 300 and 400 amp d-c welders automatically adjust welding voltage during use. Welding range of the 300 amp machine is 60 amp minimum at 20 v and 375 maximum amp at 40 v, while the range of the 400 amp machine is 80 amp at 20 v and 500 maximum at 40 v. There is a 2 KW, 80 v d-c outlet provided for operation of tools and floodlights. Only indicators for electrode size and for desired current have to be set to operate either unit. *A. O. Smith Corp.*

Circle No. 13

Mineral solvent

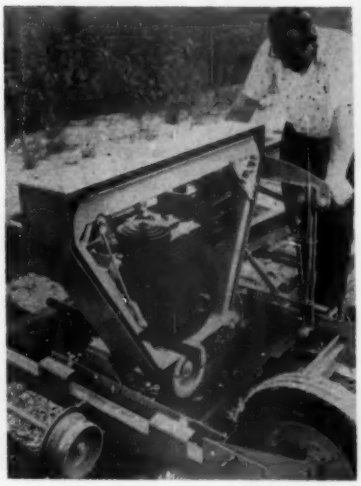
Necon-101 rust and scale solvent will dissolve most mineral scales. Highly concentrated and containing a specially prepared inhibitor, the solvent does not affect steel surfaces. *Northeast Consultants, Inc.*

Circle No. 14

Rail grinder

Portable rail surface grinder with a continuous abrasive belt is used where battered or flattened rail ends have been built up by welding. Powered by a 4-cycle air cooled engine, the grinder is mounted on 16-in. semi-pneumatic-tired wheels, and is pushed from place to place wheelbarrow fashion. The grinding belt for contouring the head of the rail is 24-grit, 106 in. long and 4 in. wide. *National Cylinder Gas Div.*

Circle No. 15



KNOWING
what you will need
IS HIS BUSINESS

Your LINDE Distributor is an independent local businessman who concentrates on knowing what you are going to want and on having it ready for you. He's a welding specialist, too, with wide practical experience and intimate knowledge of local industry. Knowing is part of his job. Maintaining adequate stocks for immediate delivery is another.

So your LINDE Distributor carries a complete line of welding and cutting equipment, industrial gases, welding rods, and supplies. He handles high-quality products of proved efficiency and recommends processes and methods best suited to your needs. His resources, plus the benefits of LINDE's 50-odd years as a leader in welding and cutting, are as near to you as your telephone.

Talk to your LINDE distributor today. Get to know him better. If you can't find his name in your telephone directory, write to: Dept. 311, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd St., New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited, Toronto.

Linde

UNION CARBIDE

"Linde" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

Power supply

Line of industrial power supplies, available in both a-c and d-c, regulate voltage, current or power for industrial processes. Designed to handle inputs to 15 KV, single or three phase, 25-60 cycles, these machines have output ratings to 100,000 amps—single phase, two phase, three phase or direct current. *Hevi-Duty Electric Co.*

Circle No. 16

Transfer switch

Heavy duty transfer switch will convert a single or two-position output induction heating generator into a dual-output system. The new switch provides two output positions for production, or four heating stations when two switches are utilized. Output connections are interchangeable with Ther-Monic A and B series generators, while the switches are intended for use in conjunction with work stations equipped with output transformers available for other makes of generators. *Induction Heating Corp.*

Circle No. 17

Relay actuator

Current relay actuation is initiated by the magnetic field created by current in a wire, when the wire is placed through the hole in the toroid. The actuator has no moving parts, eliminates mechanical timers and has no upper current limitations. The unit operates for both a-c and d-c systems. *L and B Electronics.*

Circle No. 18

Wire marker

Hoffman wire marker is designed to be set up between wire drawing stand and take-up reel for marking code numbers, trade names, etc. Consisting of a roller die plus an idler roller containing grooves to guide various size wires, the wire is accurately positioned and kept at the proper tension for marking. *Quality Die Co.*

Circle No. 19

Finishing medium

Type Q pink quartz, processed into shapes predominantly cubical, is a barrel finishing medium. Finer textured than other quartz previously used, its smoothness of surface permits use in burnishing. Sizes range from 00 through 6. *Techline Div. Wheelabrator Corp.*

Circle No. 20

Induction heater

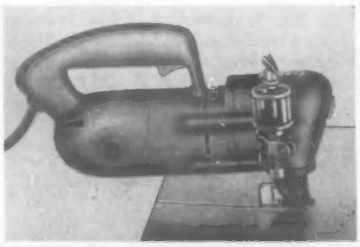
High frequency induction heating unit, with 10 KW output, operates at four megacycles for processing semiconductors and other conductive materials. Model LI-10C-1 has a totally enclosed cabinet for dust and fume protection of components. Power input is 230/460 v, 3 phase, 60 cycles, with a power consumption of 20 KVA maximum at 90% power factor. Water consumption, at full load, is 6-7 gpm at 80 F. *Lindberg Engrg. Co.*

Circle No. 21

Nibbler with lubricator

Self-oiling lubricators for portable nibblers produce faster cutting and a more even edge, says manufacturer. The oil flow is regulated by an adjustment on the dispenser, according to the density of the oil used. Two models of the lubricator are available for the firm's various nibblers. *Modern Mfg. Co.*

Circle No. 22



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CHOSEN BY SKILLED WELDERS for extra heat protection, greater finger dexterity, and all-around comfort. Horsehide and "Flextan" leathers stay soft after dry-cleaning. Exposed seams completely welted. Seamless backs.

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GENUINE HORSEHIDE PALM No. 956
Horsehide Palm, clute pattern cut extra long to prevent wrist chafing, and fourchetted for extra comfort and dexterity. Welted and wool-lined for complete protection.

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Green "Flextan" leather, excellent protection, flexibility of finger movement.

SPOT WELDER No. 897
For lighter jobs, unlined green "Flextan" leather.

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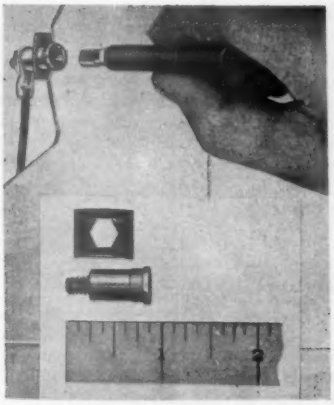


Electrical connection

Model WA-014 receptacle and mating plug incorporate a positive locking connection with light pressure contact for connecting and disconnecting wires. Only ⅞-in. long, the receptable is knurled to prevent rotation when placed in panel. Easily installed, the unit is further locked into position with a speed nut. *Cam-Lok Div.*

Circle No. 23

Control valves

Inproved line of Speed King plug-in type ¼ in. pilot-operated control valves afford compact size, fast operating response, long dependability and low cost, says manufacturer. Featuring a one-piece solenoid pilot housing and an aluminum body and sub-base, the unit automatically completes electrical, pneumatic or fluid connections as the body and pilot are bolted into place. Designed for 30 to 200 psi service, the valves are available with solenoid coils for a-c or d-c, any voltage. *Valvair Corp.*

Circle No. 24

Profile milling machine

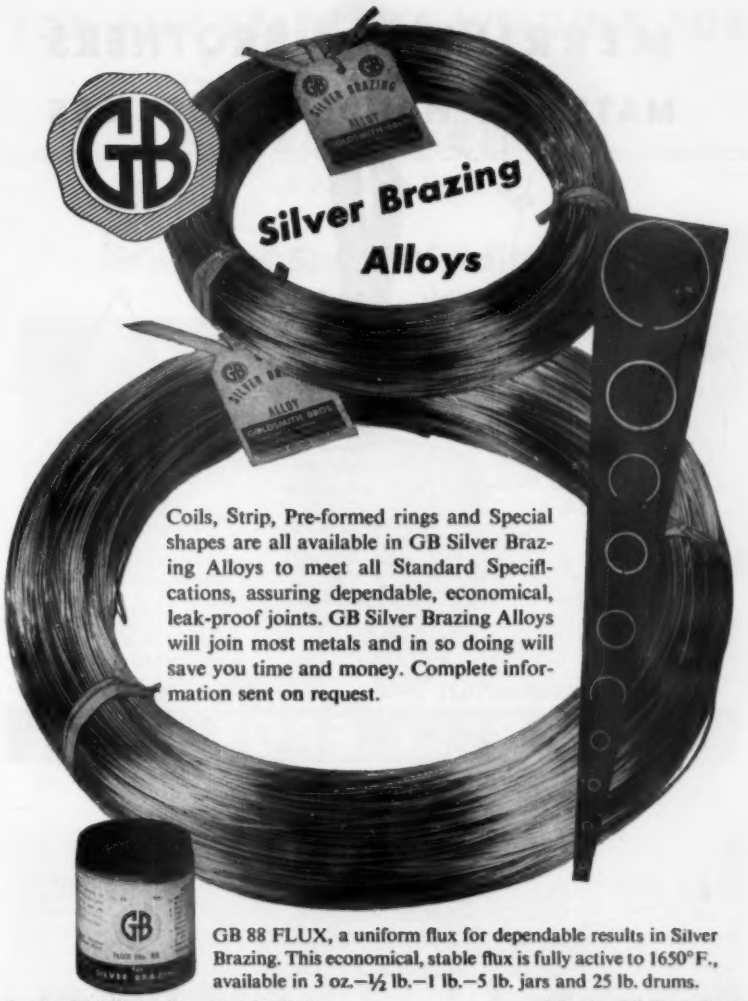
High-speed profile milling machine cuts simple radii or irregular shapes with no set-up or layout. Available in standard semi-automatic or fully automatic models, the operator simply slips the material into a vise and moves a handle through the 180 deg arc. On the automatic model the tool feed is pushbutton control actuated. The machine requires less than 10 sq ft of floor space. *The McKay Machine Co.*

Circle No. 25

Coiled steel handler

Upending and rotating ram and fork attachment for use on a heavy-duty electric truck simplifies the handling of coiled steel. With a capacity ranging from 15,000 to 20,000 lbs, the six major movements of the unit are controlled by twenty-one separate hydraulic functions. The versatility of the attachment is accomplished with a pair of rotating forks, a pivoting ram and independent side-shifting of either ram or forks. *The Yale & Towne Mfg. Co.*

Circle No. 26


GB
Silver Brazing
Alloys
Coils, Strip, Pre-formed rings and Special shapes are all available in GB Silver Brazing Alloys to meet all Standard Specifications, assuring dependable, economical, leak-proof joints. GB Silver Brazing Alloys will join most metals and in so doing will save you time and money. Complete information sent on request.
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GB 88 FLUX, a uniform flux for dependable results in Silver Brazing. This economical, stable flux is fully active to 1650°F., available in 3 oz.–½ lb.–1 lb.–5 lb. jars and 25 lb. drums.

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HAVE YOU INVESTIGATED THE POSSIBILITIES OF LOWERING YOUR METAL JOINING COSTS BY SWITCHING TO SILVER BRAZING ALLOY ?

MERRILL MB BROTHERS
MATERIAL HANDLING DEVICES

- Safety Factor—5 to 1
- Factory tested at triple rated capacity.
- Will lift from horizontal or vertical position.
- Cam and Pads of case hardened tool steel.
- All operating parts replaceable when worn.
- Swinging or jerking loads will not affect grip.
- Useful for positioning in welding operations.

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last longer when rebuilt with
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11¾-13½% MANGANESE-NICKEL STEEL
APPLICATOR BARS & WELDING ELECTRODES

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- Extreme toughness prevents chipping or spalling.
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WRITE FOR COMPLETE DETAILS AND NEAREST DISTRIBUTOR

Abrasive discs

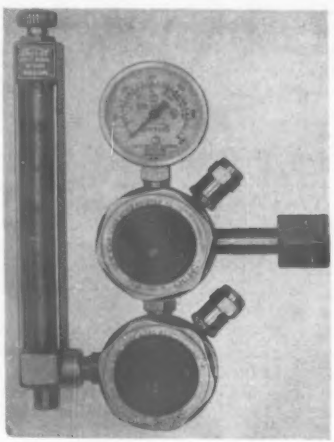
Giant Brand abrasive discs are now available for every type of portable right-angle grinding. Manufactured under the Magnecoating process, which vertically positions grit particles for greater concentration the new additives include both resin-bonded depressed center wheels and cup wheels. *Abrasive Co. of America.*

Circle No. 27

High production lathe

Gallic 16-in. metal lathe, with hardened and ground ways, also has Nichrome Steel spindle running through high precision roller bearings. Equipped with a two speed 10/7.5 hp motor, the unit has spindle speeds varying from 40 to 2000 rpm, with an alternate range of 28 to 1400 which can be affected with 16 speed ranges progressively arranged. The lathes are built 16 by 40-in. and 16 by 60-in. *Index Industrial Corp.*

Circle No. 28



Flow meters

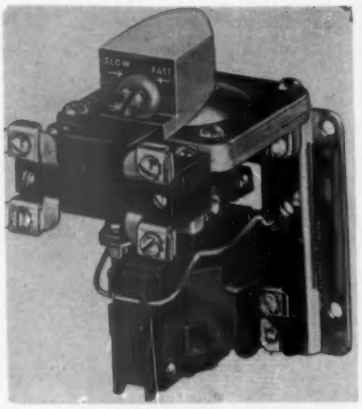
Flow meter regulators which accurately measure argon and helium used in inert-gas shielded welding afford important savings, says manufacturer. Featuring an extra long meter tube and a unique center guide for the ball float, the meter is said to be accurate to within 2% of full scale reading. The pressure setting from a full cylinder can be held accurately to 50-75 lb inlet pressure. *Smith Welding Equipment Co.*

Circle No. 29

Air-powered grinders

Straight-air grinders of improved design have 100% increase in power, with the increase in weight so slight that they remain in the 10 lb. class. An over-speed control shuts off the air when overspeeding arises, and exhaust deflection can always be directed away from the operator by a movable motor housing deflector. The No. 5 series of grinders are available in speeds of 4500 or 6000 rpm. *Thor Power Tool Co.*

Circle No. 30



Pneumatic timer

Timer with an internally ported air system is suited for applications in dusty or dirty atmospheres. Available in either a-c or d-c, the timer has a timing range which is adjustable from .2 seconds to 1 minute. *Square D Co.*

Circle No. 31

Ceramic transducers

Glennite Hi-T transducers, capable of good performance up to 750 F, are fabricated from ferroelectric materials. Requiring no cooling, they are applicable to ordinance systems and high temperature electromechanical sensors. Hi-T are supplied in standard frequency tolerances of ±10% (with closer tolerances permissible down to ±1%) and in the standard shapes. *Gulton Industries, Inc.*

Circle No. 32

Induction coil

Ther-Monic Master Coil set with blank inserts is available for all generators, making it easy to change and adjust a complete work coil assembly. The unit is available in 2 sizes—the small coil has an ID of 2 in., with inserts pre-drilled with openings from ¼ to 1⅜-in.; the 4 in. large master coil has inserts from 1⅝ to 3⅛-in. Single turn construction of the Master Coil offers low coil voltage to eliminate breakdown of the unit. *Induction Heating Corp.*

Circle No. 33

Air cylinder

Pancake line of low pressure air cylinders permits utilization of air power in confined space. Offered in pressure ratios ranging from 1:1 (line pressure) to 3 times line pressure, the cylinders have strokes from .010 to 1 in. *Fabco.*

Circle No. 34

Vacuum furnace

High vacuum furnace is used for brazing and heat-treating of the "problem" metals. With a 24 in. diameter cylindrical work area 24 in. high, the furnace can hold a vacuum of 10-6mm of mercury at room temperature and 10-4mm in the 1800-2000 F range. The furnace is expected to exceed 2300 F. *Pyromet Co.*

Circle No. 35

FOR ANY STAINLESS WELDING JOB

Drawalloy
CORPORATION

Stainless Steel Welding Wire

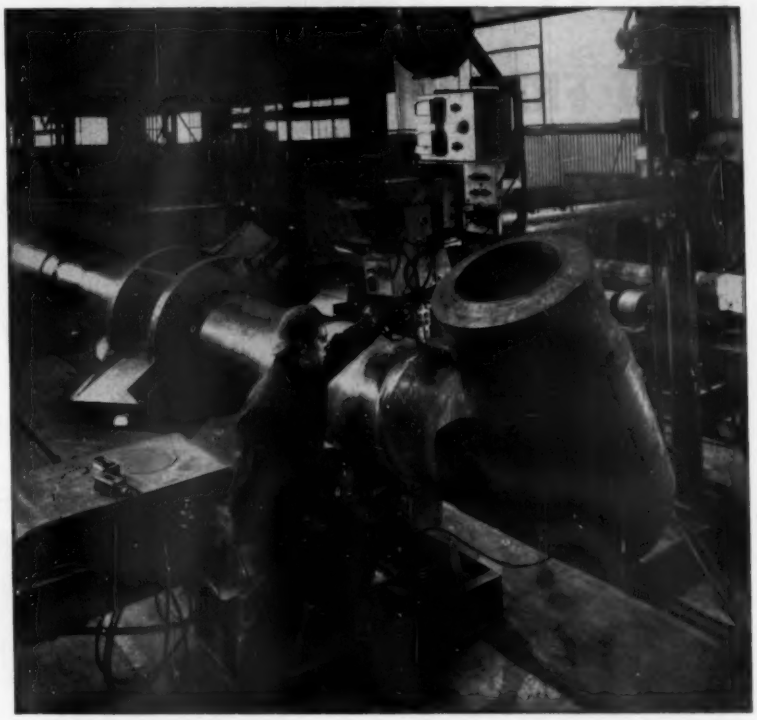


Photo courtesy of National Valve and Manufacturing Co., Pittsburgh, Pa.

Specify Drawalloy "quality controlled" stainless steel welding wire for *your* next "quality weldments." Your greatest advantage is experience . . . our experience in producing wires for welding exclusively. Because we are specialists, Drawalloy stainless steel welding wire is produced to strictly controlled specifications to provide the right chemistry, finish and temper for the finest quality weld metal and smoother operation in your automatic or semi-automatic equipment. Drawalloy stainless wires are available in all popular grades as well as 2¼ Cr, 1 Mo; 1¼ Cr, ½ Mo.

Why not discuss your stainless welding wire needs with your Drawalloy Distributor or Representative . . . a man with the products and knowledge to help you. Bulletin 355 DC provides complete information on every grade of Drawalloy wire. Write to: Drawalloy Corporation, Lincoln Highway West at Alloy Street, York 12, Penna.

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THE WIRE MILL FOR THE WELDING INDUSTRY

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MODERN, STRATEGIC DEFENSE PLANNING . . . WELSH WELDERS' FLASH SPECTACLES!

Protects against impact, light or flash hazards where a completely enclosed, cup type, safety goggle is not required.

Lenses meet all Federal specifications . . . are made of heat treated glass.

Style 3261
Sturdy, precision-made, metal frame spectacles with solid plastic or leather side shields.

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Rugged, comfortable butyrate frame spectacles with solid or perforated side shields.

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W E L S H — Willingly Worn By Workers Everywhere

Valving machine

Model 200BE valving machine features an automatic electric control for the valve wrench drive. Controlled by the amount of torque being applied by the valve wrench, the control stops the wrench at a predetermined torque setting and automatically inserts all valves to a uniform leakproof tightness. Slip-On Inserts for valving of different size cylinder valves can be changed without tool or interruption of procedures. *Independent Engineering Co.*

Circle No. 36

Timing head

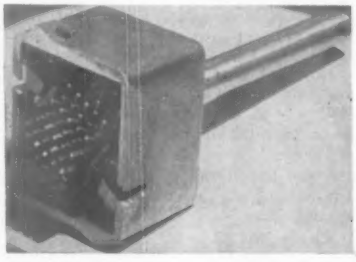
Timing sequence head for use with Speed King and Inline valves eliminates timers and relays in circuits requiring time delay. Designed for time-in, time-out or both, the delay in valve function is adjustable from 0 to 30 sec on the standard head, and with an accessory reservoir, can be extended to several minutes. The installation of the head adds only 1¼-in. to the height of the assembly. *Valvair Corp.*

Circle No. 37

Wheel dresser

Model 10 grinding wheel dresser is a low cost, heavy duty dresser made of high tensile strength cast aluminum. The specially developed cutters and abrasive wheel of the unit are interchangeable. The dresser will fit standard Peterson cylinder heads and Lempco grinders. *L. Newman.*

Circle No. 38



About people . . .

Wade

New vice president in charge of distributor products for Linde Co., New York City, is *Sidney Wade.*

Williams

Robert F. Fox has taken over the position of national sales manager of Eutectic Welding Alloys Corp., Flushing, N. Y.

David Williams has joined the sales department at Fibre-Metal Pacific Inc., Bell Gardens, Calif. He will cover the San Francisco Bay area contacting distributors in a wholesale capacity only.

Olson

George O. Pfaff is director of marketing at Wheelabrator Corp., Mishawaka, Ind. He will be responsible for general products and Techline Div. equipment and sales.

Twentieth Century Mfg. Co., Minneapolis manufacturer of welders and air compression units, has a new chief engineer—*Ellis W. Olson.*

Emerson Electric Mfg. Co., St. Louis, has added three top executives to the advisory committee of the board of directors. They are *E. L. O'Neill,* vice president and general sales manager of Emerson Electric; *W. L. Davis, Jr.,* vice president of engineering; and *C. G. Gulledge,* vice president of Electronics & Avionics. Also, *W. R. Gereau* has assumed the job of laundry motor sales supervisor.

Preston L. Scott has been named district sales manager for arc welding equipment and electrodes in North and South Carolina, Georgia, Florida and part of Tennessee for Hobart Bros. Co., Troy, Ohio.

Bren Weld Corp., Brooklyn, has recently placed *Joseph F. Sharpe* in the position of sales manager.

New St. Louis territory sales manager for Smith Welding Equipment Corp., Minneapolis, is *Donald E. Cummings.*

O'Neill

Davis

Gulledge

on "tough" snagging and grinding operations . . .

. . . if PRODUCTIVITY is what you want!

PRODUCTIVITY is what you get!

with the VEE-ARC 2 HP PORTABLE GRINDER

This **NEW** powerful but light-weight grinder does **MORE WORK** with less operator fatigue . . . **DESIGN-ENGINEERED** for use with **9"** disc wheels . . . can be plugged into nearest 120-v. AC power outlet . . . **LIFE-TIME LUBRICATED** . . . **TAMPER-PROOF SEALED** . . . **SIX MONTHS WARRANTY.** All this . . . and more for only **$168.00** f.o.b. nearest distributor.

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HOW TO SAVE TIME and MONEY ON YOUR PIPE FABRICATION WORK

Put this "one-man pipe shop" to work in your plant

Produces straight or beveled cut-offs, saddle and insert type tee intersections, lateral intersections and miters. Extremely simple to operate. Pipe is laid on rollers. The horizontal reciprocating movement of the cutting torch is automatically guided and synchronized with the rotation of the pipe to produce the contour of the cut desired. Used by oil refineries, constructors, pipe fabricators, aircraft companies, tank manufacturers, etc.

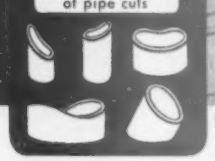
SOME OUTSTANDING PANTOGRAPH FEATURES and ADVANTAGES

- Handles any length pipe.
- No chucking required.
- No layout or templates required.
- No hand trimming—cuts are smoothly finished and beveled.
- Makes uniform cuts on production runs.
- Two models available—Model C (shown)—handles pipe from 2" to 24" diam. Model G for pipe up to 42" O.D.

WRITE FOR BULLETIN NO. P-10

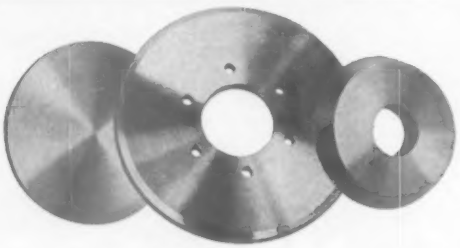
VERNON TOOL CO., LTD., 1101 MERIDIAN AVE., ALHAMBRA, CALIFORNIA

Typical samples of pipe cuts



VERNON "PIPE-CUTTING" PANTOGRAPH

TUFFALOY



Quality, Precision, Service!

The same high-quality alloys used in TUFFALOY spotwelding tips supply the forgings and plate stock from which these resistance welding parts are made.

Seam Welding Wheels are finished to your specifications or supplied as rough forgings; consult the TUFFALOY stock list for sizes immediately available. Replaceable rings are often economical to retread larger or water-cooled wheels.

Special Tuffaloy Parts, such as the two dies and the seam welding shaft shown here, are other examples of what TUFFALOY means to you in *quality* alloys, *precision* machining, *prompt* service.

Tuffaloy resistance welding alloy products are widely available through Airco and Tuffaloy representatives. Call on them for SPOTWELDING TIPS (Standard, 'Tuffcap', Cold-Bent, and Special), Holders and Adapters, BAR STOCK, FORGINGS, SEAM WELDING WHEELS, and all other welding alloy needs. Ask for Catalog and Price List.

AIRCO

AIR REDUCTION SALES COMPANY

A Division of Air Reduction Co., Inc.

150 East 42nd Street, New York 17, N.Y.

Brown

Peacock

Richard K. Brown has been appointed vice president and general manager of National Welding Equipment Co., San Francisco. He was formerly general sales manager, and has been replaced by *C. B. (Bart) Peacock.*

J. J. Koss has been appointed Milwaukee district sales representative for the Babcock & Wilcox Co.'s Tubular Products Div. *T. J. Nagle* succeeds Koss as sales representative in the Chicago district office.

Openings for sales representatives for the Michigan District Office of the Metallurgical Products Dept., General Electric Co., Detroit, have been filled by *Bruce Best* and *Edward L. Boersig.* Best will cover Detroit and Toledo, with Boersig in eastern Michigan.

Robert E. Johnson is general sales manager for the Princeton (N.J.) Div. of Curtiss-Wright Corp. He will coordinate the sales activities of the Industrial Controls, Nuclear Radiation, Nondestructive Testing, and Solar Energy product groups. *Robert Greiff* is assistant sales manager for Industrial Control Products, designers and producers of nuclear thickness gages and electronic systems used in manufacturing continuous strip products.

A new management team has been formed to expand research and production activities of Tatnall Measuring Systems Co., a Budd Co. subsidiary in Phoenixville, Pa. The team is headed by *Dr. John H. Buck* and is composed of *J. E. Starr, Dr. Felix Zandman* and *E. S. Bowkley.*

Herman J. Galamba, of Sonken-Galamba Corp., Kansas City, Kans., was elected president of Aluminum Smelters Research Institute at a recent meeting.

Gene M. Brown is public relations manager of Olin Mathieson Chemical Corp., New York City. The company's metals division has named its vice president of brass sales, *David T. Marvel,* representative to the Copper & Brass Research Association.

Berlin

Arthur Berlin is now eastern division sales manager for Sight Feed Generator Co., West Alexandria, Ohio. He will headquarter in a new division office at 790 Broad St., Newark, N. J. One of the firm's chief engineers, *Donald W. Smith,* is in Algiers training personnel in use of company automatic welding equipment.

Robert Cushman has been appointed general sales manager of the Abrasive Div., Norton Co., Worcester, Mass. *W. Alex McCune* succeeds him as sales manager of grinding wheels. *H. T. Pierpont* is sales manager of abrasives, succeeding the retired *G. A. Park. W. A. Russell* assumes McCune's former post as manager of field sales, grinding wheels, and *D. H. Paul* is district manager in Detroit.

Donald E. Cummings has been named general manager of the newly formed Industrial Gas Div. of Air Products Inc., Allentown, Pa. The new group will coordinate marketing of gases to industrial customers and steel mills.

T. C. Fair, formerly with National Cylinder Gas, is sales engineer in Pittsburgh for Coast Metals Inc., Little Ferry, N. J., producer of brazing powders and hardfacing materials.

E. W. Bonness was recently selected consultant to the director of manufacturing, Industrial Group, at Allis-Chalmers West Allis Wisconsin Works. *Russell A. Hedden* replaces him as works manager of manufacturing.

M. W. McAuliffe has been appointed San Francisco Bay area sales representative of the Pyromet Co. He will promote the brazing and heat-treating services of the San Francisco firm.

The Society of Mining Engineers of AIME has elected *Dr. Arthur B. Cummins* president for one year. He is manager of central research, Johns-Manville Corp.

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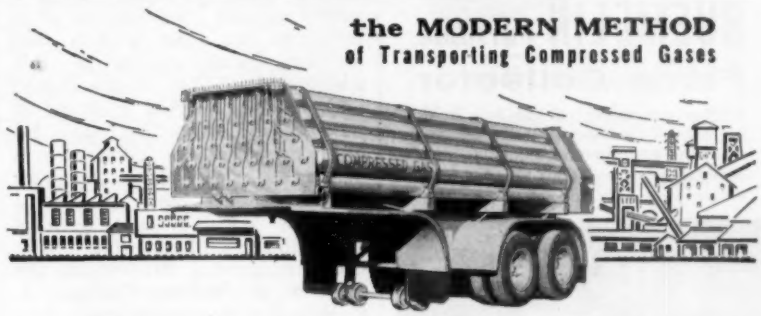

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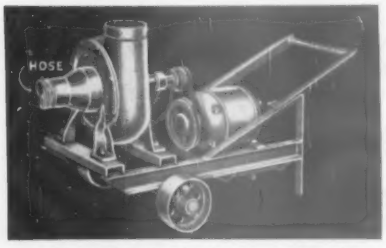

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Bickel

Baird

Wayne E. Bickel and *James H. Baird* have recently been appointed to the Gas Plant Equipment sales staff of Bastian-Blessing Co., Chicago. Both are at the factory to service the company's line of high pressure gas control and utilization equipment.

Edmund W. Dugan has been named to head a Washington, D. C., office being established by Chemetron Corp., Chicago. The new location will be in the Moreschi Building, 905 16th St., N. W. At the same time, *Robert E. B. Orton* was appointed carbon dioxide sales representative in the Boston area for the firm's Cardox Div.

A. O. Smith Corp., Milwaukee, has made the following personnel changes: *D. H. Buerkel*, formerly Philadelphia district sales manager, has been named regional sales manager of all industrial east coast welding sales activities, headquartering in Philadelphia. *J. B. Ray* is now district sales manager for New York and all New England states. The region between the Pittsburgh industrial area west through the Dakotas, Nebraska and Kansas has been consolidated into one regional sales territory under direction of following district sales managers: *A. M. Brinson*, Detroit; *W. P. Finneran*, Chicago; *A. R. Schneller*, Milwaukee.

Richard S. Halladay and *Robert P. Smith* are sales engineers, Nuclear Systems, a division of Budd Co., Philadelphia. Both will headquarter in Chicago.

Died . . .

Eugene K. Butler, 52, died Saturday, Sept. 12, after suffering a heart attack. He was manager of marketing services for Belden Mfg. Co., Chicago, whom he joined in 1933.

Horace B. Horton, 73, died Sept. 17. He was board chairman of Chicago Bridge & Iron Co., Chicago, a firm founded by his father in 1889. Mr. Horton was employed by the company since 1907.

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Brazing titanium

BRAZING TITANIUM SANDWICH CONSTRUCTION. By J. F. Rudy, R. M. Necheles, and Harry Schwartzbart, Illinois Institute of Technology for Wright Air Development Center, U. S. Air Force. January, 1959, 98 pages. Price, $2.25. (Order PB 151663 from OTS, U. S. Dept. of Commerce, Washington 25, D. C.)

This volume identifies the face sheet alloys, brazing alloys, and fabrication methods used to show the feasibility of fabricating titanium alloy face sheet honeycomb sandwiches by brazing techniques.

The book tells which alloys were selected for brazing several types of face sheet alloy, and which alloys proved to be the strongest.

Also explained is a quartz lamp radiant heat brazement process developed and found applicable to titanium alloy face sheet materials and sandwich panel production in general. The technique showed many advantages over other furnace retort methods, such as inherent rapid heating and cooling rates, good temperature uniformity and brazing time control, and cleanliness of the heat source for atmosphere purity.

Nondestructive testing

NONDESTRUCTIVE TESTING HANDBOOK. Ronald Press Co., New York City. Two volumes, $24.

A rapidly expanding engineering science comes of age with the issuance of the first *Nondestructive Testing Handbook*. It integrates the experience acquired throughout industry to date in selecting, applying and interpreting tests designed to improve performance reliability of equipment, to cut costs, to insure product quality or uniformity, to increase the utilization of materials, and reduce breakdowns and accidents.

From all over the world, the handbook draws together information from such significant and widely scattered sources as professional journals, society proceedings, committee reports and records and reports of designers and users of testing equipment. Much of the test application and interpretation is made available for the first time, particularly in advanced fields such as penetrating ra-

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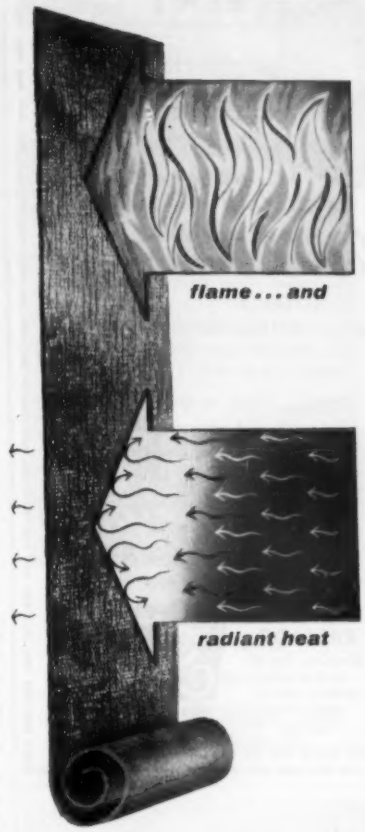

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The book is edited by Robert C. McMaster of The Ohio State University with a board of 106 contributing and consulting editors selected from this country and abroad.

Organized in 54 sections, the handbook offers hard-to-find guidance for every organizational level—from top management to those who conduct tests, prepare reports and maintain records. Over 1,200 charts, drawings, forms and photographs are included, along with much newly developed data in graphic or tabular form.

Rockets and missiles

MATERIALS FOR ROCKETS AND MISSILES. By Robert G. Frank and William G. Zimmerman. Published by the MacMillan Co., New York City, 1959. Cloth, 5 by 7½ in., 128 pages. Price, $4.50.

Materials for Rockets and Missiles is a pocket size volume of information dealing with the materials used in rocket and missile construction.

There is contained all types of vital information dealing with the mechanical properties and other factors of such materials as iron-nickel and cobalt-base sheet alloys, and wrought alloys, as well as cast alloys of these groups, and wrought and cast aluminum and magnesium alloys, titanium alloys, cermets, molybdenum alloys and ceramics.

Chapter 10 discusses material fabrication developments, and deals somewhat with high temperature brazing of thin materials. Chapter 11 is devoted to interpreting the data presented elsewhere in the book. There is also included a bibliography and index.

Notch sensitivity

TESTING FOR NOTCH SENSITIVITY IN WELDED JOINTS. By C. E. Hartbower, Watertown Arsenal, U. S. Army Ordnance Corps. (Order PB 151630 from OTS, U. S. Dept. of Commerce, Washington 25, D. C. Price, 75 cents.)

A critical review of selected papers dealing with the evaluation of notch toughness in steel by means of the V notch Charpy impact test is presented.

Past objections of metallurgists and designers to this particular test are discussed. The study's purpose was to show that it is possible to evaluate notch toughness in a welded joint as well as in the unwelded base metal.

The study concludes that the V notch Charpy impact test provides an excellent means for evaluating the relative toughness of weld, heat affected zone, and base metal, providing that certain procedures are fol-

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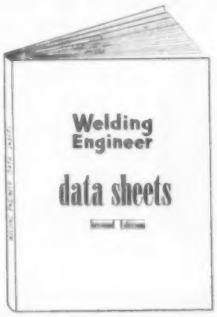

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lowed and that a significant criterion of performance and definition of temperature are selected. Methods for accurately accomplishing these evaluations are presented.

Industrial relations

GLOSSARY OF PERSONNEL MANAGEMENT AND INDUSTRIAL RELATIONS TERMS. Published by Society for Advancement of Management, New York City, 1959. Paper, 5½ by 8½ in., 40 pages. Price, $2.

In a compact booklet the Division of Management Research Development of the Society for Advancement of Management has defined 300 critical terms dealing with personnel management and industrial relations. It is believed that this book will be helpful in cutting down misunderstandings, litigations and delays while promoting the growth of common understanding and acceptance of the language of the fields.

Joint strength

ARC-WELDED JOINTS. By La Motte Grover. Published by the Arc Welding Section of the National Electrical Manufacturers Association, New York City, March, 1959. Price, 25 cents.

This profusely illustrated book is divided into two parts—Strength of Arc-Welded Joints and the Arc-Welding Processes. Also included are a glossary of terms, master chart of welding processes and the American Welding Society chart of standard welding symbols.

The first part of the book is intended to supplement the general text books on elementary strength of materials that are used for undergraduate engineering study.

The student is provided with the basics of the methods for applying the principles of mechanics of materials to the proportioning of simple arc welded joints and connections, to conform to requirements for nominal working stresses.

The discussion of arc-welding processes in Part II is provided mainly for general interest and reference.

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76. WELDING CABLES—Simplex Wire & Cable Co. Super-flexible, single conductor welding cable—and selenium neoprene armored, cured-in-lead cable—are detailed in brochure titled "Cables for Welding Equipment".

77. ELECTRODE HOLDER — Jackson Products. Description of new Sealed Tight mechanical cable connection, as well as specifications of Series ST electrode holders, are detailed on flyer 10-ST.

78. VOLTAGE REGULATOR — General Electric Co. Ratings, dimensions and application data on Inductrol voltage regulator, using the induction principle for stepless regulation and an infinite number of output voltage levels, is given in bulletin GEC-1450.

79. BRANCH CONNECTION—H. K. Porter Co., Inc. Folder TF-2-M, with an interesting product pop-up, shows ease of installation and tells of safety and low costs of Fishmouth pipe connections.

80. PORTABLE GRINDER—Vee-Arc Corp. Bulletin 1500 gives specifications and description of 2-hp Model H grinder, for use with a 9-in. disc wheel.

81. WELDING CUPS AND NOZZLES—Diamonite Products Mfg. Co. Discussion of the reasons for the superiority of high alumina ceramics in the manufacture of welding shields, as well as a description of the company's full line of welding cups and nozzles, are covered in Welding Shields bulletin.

82. DIE ALLOY—Ampco Metal, Inc. Di-Bronze alloy for drawing, forming or bending stainless and clean mild steel is described, and typical applications given, in Bulletin G55.

83. SPOT X-RAY—Carl Brenck Electro-Technical Laboratories. Model P130 one tank portable Fedrex X-ray set, weighing 53 lb and capable of penetration of 1½-in. steel, is featured on catalog sheet.

84. ULTRASONIC TESTER — Curtiss-Wright Corp. Flyer titled "Portable Ultrasonic Immerscope" gives complete information on immersion testing and quality control installation for use in laboratory or light production facility.

85. SPEED CHANGERS—Metron Instrument Co. Series 2 miniature adjustable ratio speed changer, whose ratios are continuously adjustable over a 25:1 range (1:5 up to 5:1 down) are topics of Bulletin 96.

86. CONTROL VALVES—Hunt Valve Co. Bulletin 582-A lists, details and gives applications of new pilot operated B-Type single and double solenoid control valves.

87. FLEXIBLE SHAFT EQUIPMENT—Wyzenbeek & Staff, Inc. Industrial catalog lists No. 59 company's line of Wyco equipment and features several new Vari-Speed transformer type variable speed flexible shaft grinders.

88. PORTABLE NIBBLERS—Fenway Machine Co., Inc. Specifications and descriptions of complete line of portable air-powered and electric nibblers capable of cutting up to 10 gage stainless and 8 gage mild steel are given in flyer.

89. FINISHING SYSTEMS—R. C. Mahon Co. Twelve page booklet A-659 gives information on finishing systems and typical custom installations, plus ideas for improvements involving drying and baking of all kinds (including special equipment employed for coating welding rods).

90. CONTOUR SAWING MACHINE—The DoALL Co. The Pan-Arm contour sawing machine, on which straight line cuts up to 17 ft long and intricate contour cuts may be made, is described and floor plan layouts and full technical specifications are given in brochure.

91. GAGELESS REGULATORS — Linde Co. Oxweld industrial gas regulators without gages, designed for use with oxygen, acetylene or propane on cylinders or manifolds, are subject of data sheet F-1295.

92. WELDING PRODUCTS—The Thermacote Co. Catalog gives complete information on all company's products manufactured and distributed to the welding trade.

93. BRAZING ALLOYS—Alloy Specialties Co. Booklet discusses various high-purity brazing alloys for copper, bronze or brass and gives complete specifications and cooling charts on standard alloy compositions for nonferrous brazing.

94. ALUMINUM BRONZE ALLOYS—Ampco Metal, Inc. Stock products, including extruded solid rounds, centrifugally-cast bars and rolled sheet and plates, are listed in Bulletin G-51, which also gives sizes, physical properties and applications.

96. ELECTRIC CLIPS—Mueller Electric Co. Complete line of electric clips—from miniaturized to welding ground clamps—and insulators are listed and detailed in catalog No. 220.

97. AUTOMATIC BRAZING—The Sight Feed Generator Co. Rexarc Twin Liquifluxer for automatically feeding the flux into the brazing flame and Liquiflux, for use with this process, are described in Form 659.

98. SHAPE CUTTING MACHINE—Linde Co. Oxweld CM-60, a fully automatic unlimited capacity shape-cutting machine, can easily reproduce from simple pencil sketches many duplicates of intricate metal parts in any length, width or thickness.

99. HORN PRESSES—The Federal Machine and Welder Co. Twelve page bulletin No. 52170A illustrates and describes the Warco line of horn presses in capacities from 50 to 200 tons.

100. CASTING ALLOYS—The International Nickel Co., Inc. Guide to the major nickel-containing casting alloys presents condensed informative data on the range of properties offered, with a fold-out section on the important properties of each alloy and its uses in various fields.

102. STUD WELDING APPLICATIONS—Nelson Stud Welding Div. Savings obtainable by the use of stud welding on specific fastening operations are shown in booklet on "Reversing the Trend in Production Costs".

104. POWER SOURCES—Air Reduction Sales Co. Reprint offers a comprenhensive guide to the proper selection of arc welder power sources for use with the stick electrodes and gas shielded tungsten-arc or gas shielded metal-arc welding processes.

106. GAS ANALYZER—Pioneer Industries. Specifications, general description and features of Viga Model 200 gas analyzer are given on flyer.

108. CYLINDER TRUCKS—Harper Steel & Supply, Inc. Pictures, details and specifications on line of welding and medical cylinder trucks, and industrial hand trucks, are given on flyer HT-200.

109. SIGMA WELDING—Linde Co. Instruction booklet F-7825, titled "How To Do Sigma Welding," gives latest recommendations for welding on all available metals.

111. OPTICAL PRODUCTS — Bausch & Lomb Optical Co. "Optical Products" is illustrated index listing current company catalogs to aid in selecting exact booklet suited to information needs.

112. ALUMINUM SOLDERING—Reynolds Metals Co. Booklet titled "Soldering Aluminum" gives latest and most complete information available on soldering this metal.

113. WELDING WIRES—Page Steel and Wire Div. Concise description of uses of 26 different analyses of submerged arc and inert gas welding wires is contained in Bulletin DH-402-C.

114. ELECTRONIC LINE TRACER—National Cylinder Gas Div. Bulletin N142-R-3 describes attachment for flame cutting machines, featuring high accuracy, easy operation and greater safety.

115. NICKEL BRAZING ALLOY—Wall Colmonoy Corp. Enginering data sheet (No. 5) discusses nominal composition, metallurgical properties and engineering properties of Nicrobraz, used for joining stainless steel.

116. HARD SURFACING WIRES — The McKay Co. Catalog HS-127 lists hard surfacing wires and electrodes, their descriptions, characteristics and typical applications.

117. CO_2 WELDING—A. O. Smith Corp. "Who's Who in CO_2" details company's three CO_2 processes, gives typical applications and resultant physical and mechanical properties.

118. SEQUENCE TIMERS—Harnischfeger Corp. Five units for sequence timing of welds, including motorized rheostat controls and punched-type programming, are detailed in "Programmed Time-Amperage Control for Critical Welding."

119. SNAGGING WHEELS—Simonds Abrasive Co. Specifications and sizes of snagging wheels for foundry use are given in illustrated file No. 2-2.

128. HARDFACING—Metal & Thermit Corp. Filing card system provides helpful data on 88 types and sizes of hardfacing electrodes and rods.

129. GALVANIZING — Metalloy Products Co. Catalog sheet gives prices and describes applications of Galvalloy to all types of metals. Product is a zinc-tin-lead alloy, containing no fluxes.

132. PRINTED CIRCUITS—Anchor Metal Co., Inc. Pamphlet contains detailed instructions of interest to design and production supervisors. Includes solder and flux requirements, and techiques of dip soldering.

WHERE TO BUY

CLASSIFIED THE WELDING SHOPPER ADVERTISING

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED and RESALE

UNDISPLAYED RATE

(Not available for equipment advertising)

1.10 a line, minimum 6 lines. To figure advance payment, count 5 average words as a line.

INDIVIDUAL EMPLOYMENT WANTED advertising rate is ½ the above rate; minimum $5, payable in advance.

INFORMATION

BOX NUMBERS count 1 line additional in undisplayed ads.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED RATE

The advertising rate is $12.00 per inch for all advertising appearing on other than a contract basis. Maximum size of display ad is 4 col. in. Contract rates quoted on request. AN ADVERTISING INCH is measured ⅞ in. vertically on one column, 3 columns—30 inches—to a page.

HELP WANTED

PLANT SUPERINTENDENT

Experienced in welded steel plate fabrication, including pressure vessels, heat exchangers and miscellaneous weldments. Must have experience in developing methods for cost reduction. Knowledge of layout and automatic welding desirable. Employee benefits include hospitalization, medical payments and profit sharing. Unusual opportunity with expanding company. Write Box No. 1172, c/o Welding Engineer, 5826 Dempster Street, Morton Grove, Ill.

WELDING ENGINEER

Development of methods for welding, brazing and other similar methods of joining NEW AND DIFFERENT materials to themselves and to each other

Development of techniques for fabrication of SPECIAL AND UNUSUAL materials

B.S. in Welding Engineering; Mechanical, Metallurgical Engineering, or Metallurgy with interest in welding and 1-5 years experience

Employee benefits, educational assistance, family relocation expenses. Homes and apartments in a variety of settings. Excellent school systems

Send resumé or letter of interest to

CENTRAL EMPLOYMENT OFFICE
Technical Personnel
UNION CARBIDE NUCLEAR COMPANY
a Division of
UNION CARBIDE CORPORATION
Post Office Box P, Oak Ridge, Tennessee

BUSINESS OPPORTUNITIES

WANTED

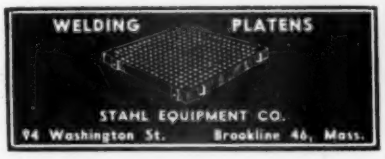
Active partner to eventually take over management of Custom Flame Cutting Shop in Los Angeles' fast growing steel fabricating market.

Equipment includes: 7-torch oxygraph, two radiographs, etc. Should have business or sales experience, preferably in custom cutting.

Write Box No. 1152 c/o Welding Engineer, 5826 Dempster St., Morton Grove, Ill.

EQUIPMENT FOR SALE

HEAVY DUTY TURNING ROLLS
for rotating pressure vessels, pipe and cylindrical bodies for welding
Aronson MACHINE CO., ARCADE, N.Y.
A COMPLETE LINE of WELDING POSITIONERS



NEW ANGLE COMPUTER

One move on simple slide rule figures length of run and angle of cut for dog legs, braces, trusses etc. Post paid $3.50 each.

BIG MIDGET PRODUCTS
2606 33rd Street Lubbock, Texas

CUTTING MACHINES, AIRCO Camo & Radiographs and NATIONAL No. 5.
SEAM WELDER, Progressive, 150 KVA, New.
SPOT WELDER, National, 40 KVA, Used.
CUTTING TORCHES, Used, Oxweld, Airco, Harris.
WELDING TORCHES, New, Rego GV.
BRONZE—STAINLESS—AMPCOTRODES.
ELECTRODE HOLDERS.
RALL SUPPLY CO. 51 E. 42nd St., N.Y.C. 17

METALLIZING WIRES
Rigidly Specified For
METAL SPRAYING
Spra-Rod CORPORATION
2795 East 88rd St. • Cleveland, Ohio • LOngacre 1-7168

EQUIPMENT REPAIR

SAVE YOUR OLD CUTTING TIPS

Send us your worn-out Oxygen-acetylene or propane cutting tips—For a fraction of the cost of a new tip we'll make those "Worn-Out" tips **GOOD AS NEW.**

Each tip will be Reseated, Redrilled, Refinished and flame tested . . . then returned to you—Ready to give you the same service as a new tip.

Your cost for this service: Only $1.25 ea. Over 100 at $1.00 ea. Terms: 2% 10 days.

We condition tips of any style or make.

Send us a trial box of tips today—Satisfaction GUARANTEED.

AMEROTIP COMPANY
"PROMPT APPARATUS REPAIR SERVICE"
1525 Taylor St., Dept. C Columbia, S. C.

SCHOOL

"UPGRADE" YOUR WELDING OPERATORS. Send them to Hobart's non-profit welding school. Specialized training for code tests and all phases of welding, manual and automatic. Newest and most completely equipped school in the country. Low tuition. Write Hobart Welding School, Box U-1191, Troy, Ohio.

WANT TO PURCHASE

Business Executive seeks Metal Fabricating & Welding Job Shop with Machine shop facilities. Product line desirable but not essential. Must have sales in excess of $1,000,000. Location desired in Mid-West area. Write Box No. 1171, c/o Welding Engineer, 5826 Dempster Street, Morton Grove, Ill.

LEGAL NOTICE

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF

Welding Engineer published monthly (two issues in June) at Chicago, Ill., for October 1, 1959.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Welding Engineer Publications, Inc., 5826 Dempster St., Morton Grove, Ill.; Editor, F. T. Tancula, 5826 Dempster St.; Morton Grove, Ill.; Managing editor, G. J. Cannizzo, 5826 Dempster St., Morton Grove, Ill.; Business manager, T. B. Jefferson, 5826 Dempster St., Morton Grove, Ill.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owner must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.) Welding Engineer Publications, Inc., 5826 Dempster St., Morton Grove, Ill.; T. B. Jefferson, 5826 Dempster St., Morton Grove, Ill.; Elsie R. Jefferson, 5826 Dempster St., Morton Grove, Ill.; Anna B. Jefferson, 12 West 58th St. Terrace, Kansas City 13, Mo.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. Paragraphs 2 and 3 include, in cases where the stockholders or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

T. B. JEFFERSON, Publisher

Sworn to and subscribed before me this 1st day of September, 1959.

[SEAL] RICHARD RICHTER

(My commisison expires Nov. 13, 1962.)

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150. Acro Welder Mfg. Co.—Write for further information on welding machinery engineered and manufactured to order.

151. Air Reduction Sales Co.—Write for more information on new Hi-Lo control for flame-cutting machine torches.

152. Alloy Rods Co.—Bulletin HS202 gives details and locations on the new "Wear-O-Matic WH" open arc welding wire.

153. All-State Welding Alloys Co.—Booklet and chart on all types of aluminum welding wire available.

154. Aluminum Co. of America—Further information and films on a loan basis, on aluminum welding and brazing processes.

155. American Brass Co.—Publication B-13 on "Anaconda" welding rods available.

156. American Platinum & Silver Div.—"A Complete Guide To Selective Fluxing For Low Temperature Silver Brazing" is available.

157. American Platinum & Silver Div.—Also available is "A Complete Guide To Successful Silver Brazing."

158. Ampco Metal, Inc.—Bulletin W-17 gives information on Ampco-Trode filler rods.

159. Amperex Electronic Corp.—Information on electronic tubes for resistance welding.

160. Ansco, Div. of General Aniline & Film Corp.—Write for further information on "Ansco Super-ray D" film.

161. Argopen Co.—Information available on the miniature inert-arc welding torch.

162. Atlantic Abrasive Corp.—Grinding wheel catalog available to help you with your metal removal or smoothing problems.

163. Atlas Welding Accessories, Inc.—Form WCT-250 available describing the "Dual Tools" and other weld cleaning tools.

164. Bernard Welding Equipment Co.—Form SS600 available on model 600 Short-stub electrode holder.

165. Cincinnati Tool Co.—Catalog available showing "Hargrave" power tested weldor's clamps.

166. Clements Mfg. Co.—Bulletins on "Clements Cadillac Model K Blowtorch."

167. Contour Sales Corp.—Data available on "Curv-O-Mark" pipe-layout tools, for marking pipes and structural angle cuts of any type.

168. Drawalloy Corp.—For complete information on every grade of Drawalloy wire, write for bulletin 355 DC.

169. Eastman-Kodak Co.—Folder available, "13 minute processing for industrial x-ray films."

170. Eutectic Welding Alloys Corp.—Information available on solutions to your welding problems.

171. Fibre-Metal Products Co.—Bulletins give details on new dual suspension for safety hard hats.

172. Flood Safety Products Co.—Information available on fiber glass helmets and other welding and safety equipment.

173. Goldsmith Brothers Smelting & Refining Co.—Data book on silver brazing available.

174. Handy & Harman—New correspondence course has simple self-study data on all phases of brazing.

175. Harnischfeger Corp.—Further information available on P&H portable welders.

176. Harrisburg Steel Co.—Write for information on gas cylinders manufactured by Harrisburg.

177. Haynes Stellite Co.—Write for "Haynes Alloys Hard-Facing Manual."

178. Hobart Brothers Co.—Further information available on Hobart welders and electrodes.

179. Independent Engineering Co.—Information available on transporting gases by gas supply trailers.

180. Invincible Vacuum Cleaner Mfg. Co.—Folder available on "Invincible Flux Recovery Systems."

181. Jackson Products—Further data available on Jackson's new "Sealed Tight" electrode holders.

182. Johns-Manville Corp.—Information available on J-M Aluminized Asbestos Cloth.

183. Lenco, Inc.—Information on "Threaded Power Connection" of Hi-Amp electrode holders, cable attachments and ground clamps.

184. Lincoln Electric Co.—Further information on "Jetweld 2" and other Lincoln Electric products.

185. Linde Co.—Complete facts on the new portable "Sigmette" torch available.

186. Linde Co.—Folder F-1313 available on the "Purox E Cutting Torch."

187. Liquid Carbonic Div., General Dynamics Corp.—Literature available on "Liquidweld" regulators and torches, also prices.

188. P. R. Mallory & Co., Inc.—Further information available on Mallory's electrodes.

189. Markal Co.—Literature and pellet samples of Thermomelt temperature indicators available.

190. Merrill Brothers—Write for further information on Merrill's material handling devices.

191. Metal & Thermit Corp.—Data sheets available on "Murex" machines for welding.

192. Miller Electric Mfg. Co., Inc.—Complete specifications on the "Gold Star" welders available.

WELDING INFO-AIDS

USE THIS CARD for Literature, Catalogs, and Bulletins shown on preceding pages and for those featured in this month's ads as listed opposite and on following page

Also information about

NEW PRODUCTS described on pages 82 to 90

Every month WELDING ENGINEER lists many new catalogs and bulletins available from manufacturers. All are yours for the asking. However, this service is valuable to you only if you use it.

USE POSTPAID CARD →

★ For copies of any manufacturers bulletins described on these pages circle the number of the items on card at right. Fill in your name, title, company and address. This has to be done only once on either post card. You need no postage.

★ For additional information on New Products described in this issue, circle the numbers of the items that interest you. The New Products section begins on page 82.

WARNING!

Illegible or incomplete addresses may keep you from receiving the information you desire. And remember, cards postmarked after the deadline date cannot be processed.

★Post card not valid after three (3) months. After that, write *directly to the manufacturer*, describing fully the information and/or literature wanted.

Name_____ Title_____

Company_____

Address_____

City_____ State_____ 11/59

NOT GOOD AFTER FEBRUARY 1, 1960

WELDING ENGINEER, P. O. Box 28, Morton Grove, Ill.

Please send me without obligation further information about the following:

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No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 32, Morton Grove, Ill.

Welding Info-Aids,
Welding Engineer
P.O. Box 28
Morton Grove, Ill.

Literature offered in ads . . . continued

193. National Carbide Co.—Additional information on calcium carbide and name of your nearest distributor available.

194. National Welding Equipment Co.—Send for illustrated folder #17 on the combination welding and flame cutting outfit called the "Five Star Pak."

195. Page Steel & Wire Div.—Folder available on submerged arc and inert gas automatic welding wire and a detailed analyses of automatic welding wires.

196. Picker X-Ray Corp.—Information on the new "Andrex" portable x-ray unit available.

197. Pressed Steel Tank Co.—Bulletin available on "Hackney" gas cylinders.

198. J. M. Ragle Industries—Information on the "Commando" drill kit and other "Commando" products.

199. Rankin Mfg. Co.—Write for data on "Ranite" hardsurfacing rods.

200. Reid Avery Co., Inc.—A complete "Raco" catalog is available.

201. Riegel Textile Corp.—Catalog available on Riegel gloves.

202. Ronan & Kunzl Inc.—Information available on liquid-oxygen storage and transport containers.

203. Ruemelin Mfg. Co.—Detailed information on the Ruemelin portable fume collector.

204. Singer Glove Mfg. Co.—Catalog on gloves and safety clothing available.

205. A. O. Smith Corp.—For complete story on automatic and semiautomatic CO_2 welding, write for booklet "Who's Who in CO_2."

206. Smith Welding Equipment Co.—Further information available on "Push Button Gas Control."

207. Square D Co.—Bulletin SM-277 contains complete story on welder control.

208. Stulz-Sickles Co.—Complete details on "Manganal" applicator bars and welding electrodes available, also name of nearest distributor.

209. Sylvania Electric Products Inc.—Additional information on Sylvania tungsten electrodes.

210. Tec Torch Co., Inc.—Write for further details on new air-cooled Tig torches.

212. Tennessee Fabricating Co.—New catalog on 400 castings designs, tubing, welding rods and machine tools and supplies is available.

213. Thermacote Co.—Send for a free Thermo Spiral Tip Cleaner and further information.

214. John Tillman & Co.—Catalog available on weldor's gloves and garments.

215. Tuffaloy Dept., Air Reduction Sales Co.—Catalog and price list on resistance welding alloy products, such as spotwelding tips, holders and adapters.

216. Vee-Arc Corp.—Further information on the Vee-Arc portable grinder available.

217. Vernon Tool Co., Ltd.—Write for bulletin No. P-10 on "Pantograph" pipe cutting equipment.

218. Victor Equipment Co.—Additional information on Victor's regulators and Victrometers available.

219. Welsh Mfg. Co.—Information on Welsh's safety goggles available.

220. Westinghouse Electric Corp.—Write for further information on the new Silicon compact Rectifier Welder.

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BUSINESS REPLY CARD

First Class Permit No. 32, Morton Grove, Ill.

Welding Info-Aids,
Welding Engineer
P.O. Box 28
Morton Grove, Ill.

Name_____ Title_____

Company_____

Address_____

City_____ State_____ 11/59

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★ **Post card not valid after three (3) months. After that, write *directly to the manufacturer*, describing fully the information and/or literature wanted.**

TIG welding is "right" for so many jobs...

Outdoor furniture made of steel tubing, is TIG-welded for smooth, slag-free welds and greater strength

Magnesium ramp for trailer trucks features rugged TIG welding of plates and channels

...and Sylvania Tungsten Electrodes do the job right...everytime!

From lightweight outdoor furniture to giant magnesium truck-ramps . . . Tungsten Inert Gas Welding is adaptable to almost any job. But the quality of the weld is only as good as the tools you use . . .

That's why TIG welders prefer Sylvania Tungsten Electrodes. You can take your pick of all 4 electrode types: Puretung®, Zirtung®, 2% Thoriated, 1% Thoriated. They're available with cleaned or ground finish. And they're color-coded to prevent waste and costly errors.

Sylvania Tungsten Electrodes are available through all leading distributors. Call yours today.

SYLVANIA GENERAL SYSTEM

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

Sylvania Electric Products Inc.
Chemical & Metallurgical Div.
Towanda, Penna.

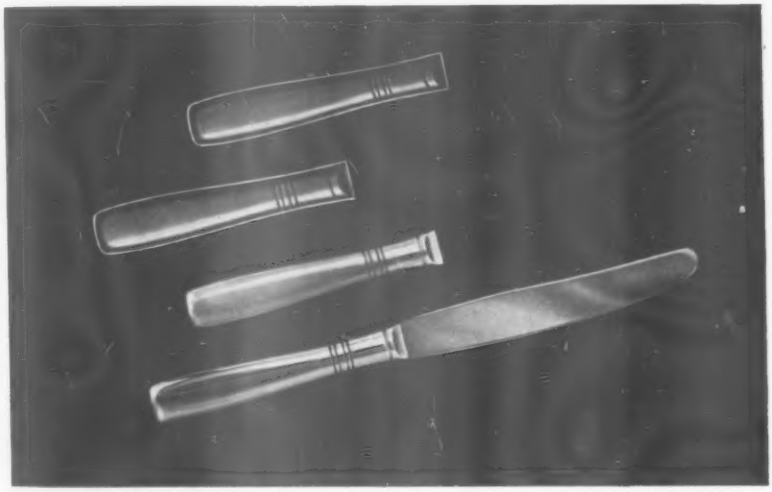
WELDING CLINIC

J. Imperati and R. F. Pulver, Welding Engineers
The American Brass Company, Waterbury, Conn.

Steel products are assembled economically with Anaconda filler metals—by brazing or braze welding

Many of the steel products encountered in our everyday lives are assembled by economical braze welding and brazing with dependable and versatile Anaconda filler metals. Among these products are home, school and office furniture, frames for wheeled toys, bicycles and portable power generators, screen and storm-sash frames, sink and refrigerator cabinets, etc.

BRAZE WELDING. The filler metals used are Anaconda-997 (Low Fuming) Bronze, Tobin Bronze®-481, and Nickel Silver-828. Their low application temperatures produce distinct advantages for oxyacetylene braze welding, such as excellent control, simple joint and fixture designs needed for efficient production, and low distortion. In addition, when molten, they easily bridge gaps in poorly fitted joints and readily build up fillets and reinforcements to develop maximum joint strengths.



TWO HALVES of stainless-steel knife handles are joined by controlled-atmosphere brazing using Anaconda Nickel Silver-828 Welding Wire at The Imperial Knife Company.

BRAZING. Most of these advantages are also available when the alloys are used for brazing in induction-heating and controlled-atmosphere furnace operations. An excellent example is the manufacture of stainless-steel handles for table knives. Imperial Knife Co. of Providence, R. I., uses Nickel Silver-828 for controlled-atmosphere brazing in production of the knife handles shown at the right, above. High-quality joints are essential for durability and good appearance, and high quality is just what this alloy confers. It develops high strength by making full-section joints, and the polished joints are inconspicuous because the alloy's color is so close to that of the steel.

The 1/16" diameter wire is cut into short lengths which are placed within the hollow handles when their two halves are assembled before entering the furnace. When the brazing temperature is reached, the molten filler metal flows by capillary action between the butted edges to bond the joint completely.

FOR MORE INFORMATION. Anaconda distributors will gladly help in the selection of the exact rod for your job. Or write for a copy of Publication B-13. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6078

SIDE OF A HOSPITAL BED being assembled at Simmons Co., Kenosha, Wisc., by braze welding with Anaconda-997 (Low Fuming) Bronze Welding Rod.

ANACONDA®
WELDING RODS
Made by
The American Brass Company